THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA.

VOLUME XIV

(BEING VOLUME VII OF THE SECOND SERIES)

1915-1918

HALIFAX

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PROCEEDINGS.

TRANSACTIONS.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1914-15.

(VOLUME XIV, PART 1.)

Annual Business Meeting.

Civil Engineering Lecture Room, Technical College, Halifax.
21st October, 1914.

The President, Donald M. Fergusson, F. C. S., in the chair.

Other members present: Dr. A. H. MacKay, Prof. E. Mackay, Dr. D. Fraser Harris, M. Bowman, Prof. H. L. Bronson, Prof. D. S. McIntosh, W. McKerron, and H. Piers.

Presidential Address: (1) Review of the Institute's Work during the Year, (2) Remarks on Valency, (3) General Remarks.—By Donald M. Fergusson, F. C. S.

It is the duty of your president at the annual meeting to speak of members deceased. That, on this occasion, is unnecessary, for, so far as I know, we have suffered no loss by death this session.

Review of Year's Work.

During the year we have had ten papers presented at our meetings, and the subject matter contained contributions in the botanical, chemical, physical, geological and physiological sciences, so that the papers read, though not above our average in number, were varied and represented different fields of research; and I may say that all the papers embody the results of much patient work and are valuable stepping stones in the path of scientific progress.

The paper that evoked the most animated discussion was that of Dr. Fraser Harris on "Coloured Thinking." Much of our recent work has been in the physical sciences, and this departure into mental science met with a hearty welcome.

Of especial practical value to the Province is the series of analyses of Nova Scotian soils contributed by Prof. Harlow. Last year we had a paper from Prof. McIntosh on the geology of the contact zone at the North West Arm; this year Mr. Vickery gives us the analysis of the contact rock locally known as ironstone. This term is somewhat of a misnomer, as "ironstone" is usually applied to an impure iron ore, but the term is used locally on account either of hardness or of the colour of the weathered rock. To contact-metamorphosed rock the general term hornstone or hornfels has been applied. We should have for this local rock of commercial utility some name for common use that would be lithologically correct.

I cannot refer to all the year's work, but I would mention the paper by Mr. J. H. L. Johnstone "On the Electrical Properties of Acetic Acid in the Solid and Liquid Phases." This, following one last year by the same author on the "Conductivity of Ice" shews one trend of present chemical research.

Remarks on Valency.

For many years past our Institute, like other scientific societies, has received papers on measurements of the dis-

sociation of various electrolytes. This field has been well explored, and the dissociation constants of nearly all electrolytes in water solution are known. Much attention is now being given to solvents other than water, and to organic substances, and, as in these papers, to matter in the solid state.

The general acceptance of Arrhenius' theory of electrolytic dissociation has led to our text books of inorganic chemistry and analyses being re-written in ionic terms. According to this, when a molecule of an electrolyte like NaCl is dissociated in solution we have a positive Na ion and a negative Cl ion. A number of years ago Sir J. J. Thomson, in his hypothesis of the electrical nature of matter, suggested that valency and cause of chemical combination consisted in the transfer of electrons between the reacting atoms. On this basis we have as positive atom one which has lost one or more electrons, and as negative atom one which has gained one or more electrons, the valency of the atom depending on the number of electrons transferred. The valency question is one of the fundamental problems of chemistry and the electronic theory has in many forms been applied as a solution. Electrolytic dissociation tells us nothing of the solid state or the gaseous. In dissociation we find H as a positive ion and Cl as a negative. What is the state of the atoms in the electrically neutral molecule of Cl? In the majority of reactions there seems to be no difference between the two halves of the molecule, but some evidence has been found that the Cl atom may act positively. On the assumption that the diatomic gas molecule consists of one atom positive and the other negative, we have theories of valency, one of which applied to the formula of the benzene ring I shew on the blackboard. Any conception of valency must pass the test of the benzene ring and explain certain peculiarities in the formation of ortho, meta, and para compounds.

In general terms of the electronic theory, the loss of electrons corresponds to oxidation, and a gain of electrons

to reduction. Many reactions are classed as oxidizing without reference to oxygen, and the term "adduction" has been proposed as the opposite to reduction: adduction means the adding of positive charges, and reduction the withdrawal of the same.

Many different electronic hypotheses have been put forward, some not involving transfer of electrons; but the final solution will come from the physicists who gave us the electron. Sir J. J. Thomson, who at one time stated that atoms of one and the same kind may be positive and negative and combine to form a diatomic molecule, in his recent work on Positive Rays, considers that for a union of atoms it is not necessary that one be positive and the other negative, but that a displacement of positive and negative electricity in each atom takes place.

It has recently been shown that if electrons are transferred in oxidation and reduction they are not the same as the beta particles evolved in radioactive changes.

Within this last two years there has been discovered a valuable method of exploring into the region of molecules and atoms. I refer to the discovery of reflection of X-rays from crystal surfaces. Interesting results are being given and, though one cannot anticipate the final outcome, we may soon have established the structure of the atom and the solution of the valency problem. Recent theories give us an atom consisting of a central positive nucleus surrounded by negative electrons. The central nucleus may not all consist of positive charges, but the net positive charge gives an atomic number corresponding to the place occupied by the element in the periodic table. In fact we are promised a periodic table containing all possible elements.

General Remarks.

As a scientific society we cannot but regret that the present war means great curtailment of research, especially on the

continent of Europe. It is hard to say what it will mean having supplies from Germany cut off, for from that country alone have come many of our necessary chemicals. On this continent it is evident that research is increasing in quantity and quality, coming not only from the universities but from governmental and endowed research laboratories and from those of private corporations, such as the General Electric Co., from the research laboratory of which I noticed recently a publication of which one of our life members was a co-author.

You will have reports presented to you from our Librarian and Treasurer, and from these you will see that we may have serious financial difficulties ahead of us. We must endeavor, however, to continue publishing the Transactions, not only for the sake of the Institute and the work of our members, but to act (as we have acted in the past) as the stimulus to scientific work in this Province by publishing the first research paper of many a student, who, receiving encouragement in the atmosphere of the Institute, leaves to make research his life work in the larger world of opportunity outside our shores.

The Treasurer, M. Bowman, presented his annual report, showing that the receipts for the year ending 21st October, 1914, were $1,742.28; the expenditures, $1,588.28; the balance in current account, $154.00; the reserve fund, $311.90; and the permanent endowment fund, $1,000, the latter being now invested in Maritime Telephone Co. 6 per cent. bonds. The report, having been audited, was received and adopted.

Dr. A. H. MacKay reported that he had interviewed the Government, and urged the restoration of the money grant which had been received by the society for many years, and he felt there was a disposition to assist in some way.

The Librarian's report was presented by H. Piers, showing that 1,766 books and pamphlets had been received by the Institute through its exchange list during the year 1913;

and 1,424 during the past nine months of the present year, 1914, viz. January to September inclusive. The total number of books and pamphlets received by the Provincial Science Library (with which that of the Institute is incorporated) during the year 1913, was 2,928. The total number in the Science Library on 31st December, 1913, was 51,810. Of these, 37,614 (about 72 per cent.) belong to the Institute, and 14,196 to the Science Library proper. Four hundred books were borrowed, besides those consulted in the library. No binding or direct purchasing has been done during the year. The report was received and adopted.

The following gentlemen were elected officers for the ensuing year (1914-15):

President,—DONALD MACEACHERN FERGUSSON, F. C. S., *ex officio* F. R. M. S.

1st Vice-President,—PROFESSOR DAVID FRASER HARRIS, M. D., C. M., D. Sc., F. R. S. E.

2nd Vice-President,—PRESIDENT ARTHUR STANLEY MACKENZIE, PHD., F. R. S. C.

Treasurer,—MAYNARD BOWMAN, B. A.

Corresponding Secretary,—PROFESSOR EBENEZER MACKAY, PH. D.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,—ALEXANDER HOWARD MACKAY, LL. D., F. R. S. C.; PROFESSOR CLARENCE L. MOORE, M. A., F. R. S. C.; ALEXANDER MCKAY, M. A.; PROFESSOR DONALD SUTHERLAND MCINTOSH, M. SC.; CARLETON BELL NICKERSON, M. A.; PROFESSOR HOWARD LOGAN BRONSON, PH. D.; and WILLIAM HARROP HATTIE, M. D.

Auditors,—WATSON LENLEY BISHOP and WILLIAM MCKERRON.

On motion, the PRESIDENT, the two VICE-PRESIDENTS, PROF. BRONSON, PROF. SEXTON, and DR. HATTIE were appointed a committee to interview the Government in regard to the restoration of the financial grant to the Institute.

First Ordinary Meeting.

Civil Engineering Lecture Room, N. S. Technical College. Halifax, N. S.; 9th November, 1914.

The President, D. M. Fergusson, in the chair.

George H. Henderson, B. A., B. Sc., instructor in physics, Dalhousie University, Halifax, read a paper on "The Distribution of the Active Deposit of Thorium in an Electric Field." (See Transactions, page 1). The subject was discussed by the President, Dr. A. S. Mackenzie, Dr. Bronson, and Dr. E. Mackay.

Second Ordinary Meeting.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, N. S.; 14th December, 1914.

The President, D. M. Fergusson, in the chair.

It was reported that Professor Alfred G. Hatcher and Lorne N. Richardson, instructor in physics and mathematics, both of the Royal Naval College of Canada, H. M. Dockyard, Halifax, had been duly elected ordinary members on the 9th inst.

Professor David Fraser Harris, M. D., C. M., D. Sc., F. R. S. E., Dalhousie University, Halifax, read a paper entitled, "Neuro-muscular Rhythms and the Tremor of Tonus." The subject was discussed by the President, Dr. A. H. MacKay, Dr. Bronson, President Mackenzie, and Dr. E. Mackay.

THIRD ORDINARY MEETING.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, N. S., 11th January, 1915.

THE PRESIDENT, D. M. FERGUSSON, in the chair.

HERBERT BRADFORD VICKERY, Dalhousie University, Halifax, read a paper entitled, "An Investigation of the 'Chromate Method' of Separating the Alkaline Earths." (See Transactions, page 30). The subject was discussed by the PRESIDENT, DR. E. MACKAY, C. B. NICKERSON, C. L. MCCALLUM, and DR. FRASER HARRIS. A vote of thanks was presented to MR. VICKERY.

FOURTH ORDINARY MEETING.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, N. S., 15th March, 1915.

THE FIRST VICE-PRESIDENT, DR. D. FRASER HARRIS, in the chair.

PROFESSOR HOWARD LOGAN BRONSON, PH. D., Dalhousie University, Halifax, read a paper entitled, "A Physical Measurement of X-Rays," (See Transactions, page 17). The subject was discussed by DR. A. S. MACKENZIE, DR. A. H. MACKAY, DR. FRASER HARRIS, and others.

FIFTH ORDINARY MEETING.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, N. S., 12th April, 1915.

THE PRESIDENT, D. M. FERGUSSON, in the chair.

PROFESSOR DONALD S. MCINTOSH, M. SC., Dalhousie University, Halifax, read a paper entitled, "Notes on an Abnormal Wave Occurrence on the Northern Cape Breton

Coast in June, 1914." (See Transactions, page 41). The subject was discussed by the PRESIDENT, DR. A. S. MACKENZIE, DR. H. L. BRONSON, DR. E. MACKAY, H. PIERS, and others.

A paper by JOSEPH PERRIN, MacNab's Island, Halifax, entitled, "Additions to the Catalogue of Butterflies and Moths collected in the Neighbourhood of Halifax, etc.," was read by title, and a vote of thanks passed to the writer.

SIXTH ORDINARY MEETING.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, N. S., 10th May, 1915.

THE PRESIDENT, D. M. FERGUSSON, in the chair.

PROFESSOR D. FRASER HARRIS, M. D., D. SC., F. R. S. E., Dalhousie University, Halifax, read a paper entitled, "Accidental Electrical Stimulation of the Human Retina *in situ*." (See Transactions, page 47). The subject was discussed by PROF. E. MACKAY, C. B. NICKERSON, DR. FRANK WOODBURY, DR. F. W. RYAN, DR. A. H. MACKAY, and the PRESIDENT.

Dr. A. H. MACKAY presented a paper on "Phenological Observations in Nova Scotia, 1914." (See Transactions, page 57). The subject was discussed by H. PIERS.

HARRY PIERS,
Recording Secretary.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1915-16.

(Vol. XIV Part 2)

54TH ANNUAL BUSINESS MEETING.

Mechanical Engineering Lecture Room, Technical College, Halifax, 13 October, 1915.

THE PRESIDENT, DONALD M. FERGUSSON, F. C. S., in the chair.

Other members present: DR. D. FRASER HARRIS, DR. A. S. MACKENZIE, DR. E. MACKAY, DR. A. H. MACKAY, CARLETON B. NICKERSON, and PROF. D. S. MCINTOSH.

PRESIDENTIAL ADDRESS: (1) Obituary Notices, (2) Review of Year's Work, (3) Some Results of the War.—By DONALD M. FERGUSSON, F. C. S., Halifax.

Obituary Notices.

Since our last annual meeting we have lost by death two of our old and valued members: William McKerron and John Forbes.

William McKerron, born in Elgin, Scotland, came to Halifax about 48 years ago. He was essentially a business man, but he took a keen interest in science, especially in those branches relating to agriculture and horticulture. For some years he acted as secretary of the Halifax exhibitions, and this position gave him opportunity to foster scientific methods amongst our farmers. He was particularly active in improving the breeds of cattle in the Province. He was a faithful attendant at our Institute meetings and could be depended on to be present whether the subject of the evening was of interest to him personally or not. He was the third treasurer of the society, serving from March, 1903 to Nov., 1906. Then he was appointed as one of our auditors, which position he filled satisfactorily until his death, which took place on March 23rd, 1915.

John Forbes, son of William Forbes, a government official, was born at Birmingham, England, January 26th, 1834. He came from England when he was between nine and ten years of age. The voyage in the barque "Manchester" took 58 days, a contrast to the time required to cross the ocean in our present day. He lived in the United States for some time, and in 1860 returned to Halifax. John Forbes was a mechanical genius, and his ideas found expression in several patents which he took out. He was manager of the Starr Manufacturing Co., and the skates made by them under his patents were known all over the world. Later on he branched out into structural work, and after leaving the Starr Mfg. Co., he entered the government railway employ. For some time he was in business for himself as president of the Forbes Manufacturing Co. On his retirement to private life he continued to exercise his inventive faculties and had a little workshop fitted up at his home. Shortly before his death he was working on a patent, and one hour's more work would have completed his model. He died June 18th, 1915, in his eighty second year. The older

members know of the interest he took in the Institute's work. Whenever I had opportunity to talk to him I found him to be a mine of information on mechanics and on the properties of metals. He was a man of sterling character and was loved and admired by all with whom he came in contact.

Review of Year's Work.

The papers presented to us this last year have been rather under the average—in number, not in quality; for as usual some of them give the results of research extending over months and years. We were all struck by the ingenuity displayed by Mr. Henderson in the construction of his apparatus from the material at his disposal, apparatus which gave him results enabling him to take issue with the theories of some of our leading experimentalists who have access to all the fine instruments which money can buy.

Dr. Harris, in order to complete his research on neuro-muscular rhythms and the tremor of tonus, requires something that cannot be built in the college laboratory. Let us hope that the doctor may soon meet some wealthy individual who will give him a vibration-free building or one at least as free as possible from vibration as human ingenuity can devise. Dr. Harris, I see from current literature, has been continuing, in collaboration with Dr. Creighton, the research into the properties of the enzyme reductase, concerning which they have in previous sessions given papers to this Institute. One fact they note, viz., that reductase is not affected by exposure to the discharges from radium bromide, and this has an important bearing on the attempts being made to use these discharges in the treatment of certain diseases. For those taking a layman's interest in this subject, I would refer to an address delivered this year before the Dublin Clinical Club by Prof. Joli. After stating the theory of the action of beta and gamma rays, he drew a parallel between the cell and the photographic

film, and detailed the action on the latter of sensitizers and developers. Among such are alkaloids, the substances in tobacco smoke, and tannin bodies. Prof. Joli, unable to find any custom of the populace to account for increase of cancer, inquired as to change of food in the last decades, and he finds an increased use of tea and coffee, both tannin containing bodies. Relative to the action of nicotine and tobacco smoke, he stated that in cases of cancer of the mouth with us, males are in a majority, whilst in the East where both sexes chew the alkaloid-containing betel nut the cases are more evenly distributed between the sexes. His suggestion is that these bodies mentioned sensitize the cells so that they are responsive to the stimulus which starts the cell into abnormal growth. Thus we have an addition to the list of food stuffs which have been blamed as causes of cancer.

Two years ago I referred to the cancer problem and it is still as pressing a subject for research as ever it was. The cell of abnormal growth is still a puzzle to medical science and biology. May we in a flight of imagination conceive the cancer cell with its abnormal mitosis as a type of the pre-evolved cell existing before Nature by trial and elimination had found the normal cell with its even and orderly division of chromosomes—the cell that survived. The ancients in their evolutionary ideas spoke of the beginings of life as shapeless masses without form, a description that fits a cancerous mass, and the active proliferation of the abnormal cell reminds one of an organism injured and doomed to die putting forth every effort to propagate its species.

The discovery of the X-rays and their then known properties by which they became a valuable adjunct to surgery made a powerful appeal to the mind of the general public. Their use to medical science has greatly increased since the early days by improvement in technique which has been progressive down to the present time, and we read of advances

made in the application of the X-rays at the battle front today. As the result of Prof. Bronson's research we have been given a method of measuring X-rays, one of certainty, and greatly in advance of previous methods which fell short of what was desired by the physicist and physician.

A year ago I referred to the remarkable results being achieved in physical chemistry by the use of X-rays in exploring the structure of crystals, etc. These researches have been continued and many papers have been published. The host of workers, Rutherford, Barkla, Moseley, the Braggs, and others have given us not only theories of atomic constitution but have shewn the distribution of the atoms in elements and compounds; and the Messrs. Bragg by X-ray methods hope shortly not only to shew the distribution of the atoms but also to give us data concerning their electronic rings. This will be of value in view of the interest being taken at the present time in the size or sphere of influence of the atoms and their compressibilities—in general, of the factors in the Van der Waals' equation.

I shall mention only one more paper. We have, as usual, had submitted to us by Dr. A. H. MacKay, the Phenological Observations in Nova Scotia for the previous year. The compilation of these data presented year after year entails a large expenditure of time and labor, gladly given on the part of our Superintendent of Education. Not only do we benefit, but the information collected now will be of greater service to those coming after us, and I trust the pioneer work of Dr. MacKay will be continued through the future generations. The collection of the data, affecting as it does almost every pupil and school teacher, must be looked on as an important part of education in our Province in that it not only opens the eye to the wonders of surrounding Nature but develops the faculty of observation and trains the child to "see".

At this point I would mention a branch of our educational system that deserves the warmest support of our Institute, viz.: the teaching of rural science, with which work some of those in front of me are connected. Many of our school teachers have been trained, and an ever increasing number are taking the necessary courses, in rural science at the college in Truro. Lately, on a visit to the country, I had the pleasure of seeing some results of the rural science work and nature study at an exhibition held in the eastern part of Halifax county. Here were shewn by the children from many schools, collections of wild flowers and plants, moths, butterflies, crop-destroying parasites, weeds, weed seeds, and specimens of rocks and minerals in the various districts. If there be in the Province any child born to be a great botanist, zoologist, or geologist it has every chance not to miss its calling and that itself is worth something to the world. The training of the faculty of observation, a fundamental to the pupil who would advance in experimental science, is a valuable asset in any walk of life; and the rising generation of agriculturalists will moreover be able to understand and appreciate, and also to cooperate in the work being done on their behalf by the various Dominion and Provincial Experimental Farms.

Some Results of the War.

A year ago, in the early days of the war, we wondered what would be the effect of shutting off the export trade of our enemies, particularly in the chemical lines. The greatest sufferers in the public eye at least, seemed likely to be the agricultural and textile industries; the former from inadequate potash supply and the latter from lack of synthetic dyes. The governments of the United States and Canada have issued pamphlets to their farmers giving advice relative to potash and urging them to conserve potash resources on the farm and prevent waste that too often takes place. The deficiency of potash has led to enhanced prices of all

potash salts used in pharmacy and the industrial arts and has spurred chemists in research toward the manufacture of potash salts from many sources. Germany, as a supplier of potash, depended, of course, on possession of great natural deposits; but her pre-eminence amounting almost to monopoly in the glass industry, in dye manufacture and in the production of the finer synthetic organic chemicals so necessary to medicine and the arts, was due to other factors. There arose in Britain and on this continent a popular outcry against the possibility of being without dyes. It is noteworthy how war brings out the elemental in humanity. In the battle front today men display primitive instinct when killing is no murder, and this popular outcry was expressive, all unconsciously, of course, of instinct and of color as a factor in sex selection.

Compared with the days of our forefathers, the improved material conditions surrounding us everywhere are primarily due to Science, and one would think that governments whose chief function is to ameliorate the condition of their peoples' lives would foster science and encourage and aid in every possible way scientific endeavor and research work. In this, to a large extent, the British Government had failed, notwithstanding appeals made year after year by her leading scientists. When the war broke out and Britain found itself dependent on foreign nations for the production of certain goods necessary to individual and national existence (dependent even on the enemy for glass for periscopes), there was at last a national awakening in which process some decidedly plain and outspoken language was used. The scientific societies under the leadership of the Royal Society offered their aid to the nation; the Government threw open enemy patents to use by British manufacturers and although such patents often hide more than they disclose, the result has been highly satisfactory. At the outset, the Board of Trade had published lists of industrial products and chemi-

cals the export of which from Britain was prohibited. The restrictions are gradually being removed, first in favor of British Colonies and protectorates and of our allies, and later in favor of other countries excepting, of course, our enemies; and Britain is now exporting many of these goods and chemicals necessary to science and the industrial arts which hitherto she had never manufactured. To cope with the dye situation the British Government has endeavored to start a national dye industry.

A committee of the Institute of Chemistry has published formulæ for glasses, from resistance-glass necessary for chemical apparatus, and hard glass, to the soft glass used for X-ray tubes; and the production of optical glass is being actively pushed. We are now able to obtain from England filter paper of high-grade quality equal to the best foreign make.

In the United States the Senate called for a report on the dye situation, and another investigation has been called for. Many concerns are taking up manufacture of dyes, chemicals, and glassware. That country can obtain the crude materials necessary for aniline dyes as bye products from the coke ovens, of a prospective annual value of $100,000,000 wasted hitherto.

Not only have British scientists aided the industries but by committees and boards of invention and research they are giving valuable assistance to the various branches of the Army and Navy in the conduct of the war.

It was brought home to the British Government (as expressed by various pleaders) that the factors in industrial progress were "organization and research", and that "scientific research work carried out in the laboratory is the soul of industrial prosperity." In our own country of Canada there has been some appreciation of science by our Provincial and Federal Governments as witness our Experimental Farms, the Geological Survey, etc.; but as an index of where

we stand let me state that it is at present impossible to start any chemical manufacture in which alcohol is used. Our legislation regarding industrial alcohol is behind that of Britain as Brita n lags behind the continental nations.

In May last there was a debate in the British Parliament on the appointment of "an Advisory Council on Industrial and Scientific Research," and never before has science received such notice in that chamber. One speaker stated that in the chemical works of Germany there was one highly trained specialist for every fifteen employees, and so important was that industry that there was one highly trained specialist in chemistry for every forty-five employees taking in all the industries of that country; and he drew a contrast with England where there were three hundred and fifty research students. He also stated, and his words will bear repetition: "I go so far as to say that eventually the whole civilization of this world and not merely that of England itself must turn on the axis of science, and as we advance we must give proportionately greater and greater importance to this great developement of scientific life."

As a result of Britain's awakening to realize the value of science and scientific research the Advisory Council and Committee were appointed, and this, we will feel assured, augurs well for the future of the mother country. Let us hope the awakening may be complete and permanent and that the lesson will be taken to heart by the Governments of her ch ldren, the Over-seas Dominions.

The presentation of the Treasurer's and Librarian's reports were deferred to a future meeting, their reports not being at hand. (See meeting of 22 February, 1916).

Dr. A. H. MacKay presented a report from the committee appointed to ask the Government, on account of

the accidental lapse of the annual grant to the Institute for the last two years, to pay, at least, the expenses of printing the Proceedings and Transactions up to date. The report stated that the balance owed to our printer on 27 July, 1915, was $776.23; and this amount, on being presented to the Government, was paid by the latter before the end of September. The society is therefore indebted to the printer, at the present time, only for vol. xiv, part 1, of the Transactions, the bill for which has not been presented.

The following were elected officers for the ensuing year (1915-16):

President,—PROFESSOR DAVID FRASER HARRIS, M. B., C. M., M. D., B. Sc. (Lond.), D. Sc., F. R. S. E., F. R. S. C., *ex officio* F. R. M. S.

First Vice-President,—PRESIDENT STANLEY ARTHUR MACKENZIE, PH. D., F. R. S. C.

Second Vice-President,—PROFESSSOR CLARENCE LEANDER MOORE, M. A., F. R. S. C.

Treasurer,—MAYNARD BOWMAN, B. A.

Corresponding Secretary,—PROFESSOR EBENEZER MACKAY, PH. D.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,—ALEXANDER HOWARD MACKAY, LL. D., F. R. S. C.; PROFESSOR DONALD SUTHERLAND MCINTOSH, M. SC.; CARLETON BELL NICKERSON, M. A.; PROFESSOR HOWARD LOGAN BRONSON, PH. D.; F. R. S. C.; WILLIAM HARROP HATTIE, M. D.; PROFESSOR FREDERIC H. SEXTON, B. SC.; and DONALD MACEACHERN FERGUSSON, F. C. S.

Auditors,—GEORGE W. T. IRVING and ALEXANDER MACKAY, M. A.

First Ordinary Meeting.

Provincial Museum, Technical College, Halifax; 8th November, 1915.

The President, Dr. D. Fraser Harris, in the chair.

It was reported that at the meeting of Council held on 2nd November, the following gentlemen, who had been proposed on the 13th October, were elected members:

Melville Cumming, B. A., B. S. A., principal of the N. S. College of Agriculture, Truro, N. S., (associate); William H. Brittain, B. S. A., professor of zoology and entomology, Truro, (associate); Percy J. Shaw, B. A., professor of horticulture, N. S. College of Agriculture, Truro, (associate); James E. Barteaux, M. A., inspector of Manual Training and Technical Schools, Truro, (associate); Loran A. DeWolfe, M. Sc., director of Rural Science Schools, Truro, (associate); J. M. Scott, M. A., M. Sc., professor of chemistry, Provincial Normal College, Truro, (associate); John Cameron, M. D., D. Sc., F. R. S. E., professor of anatomy, Dalhousie University, Halifax, (ordinary); Albert G. Nicholls, M. A., M. D., D. Sc., F. R. S. C., professor of pathology, Dalhousie University, Halifax, (ordinary); John G. McDougall, M. D., C. M., lecturer in clinical surgery, Dalhousie University, and assistant surgeon, Victoria General Hospital, Halifax, (ordinary); George Hugh Henderson, M. A., B. Sc., instructor in physics, Dalhousie University, Halifax, (ordinary); Hubert Bradford Vickery, B. Sc., sicence master, Bloomfield High School, Halifax, (ordinary); and Donald J. Matheson, B. Sc., senior master, Halifax County Academy, Halifax, (ordinary).

A paper by E. Chesley Allen, of Yarmouth, N. S., entitled, "An Annotated List of the Birds of Yarmouth and vicinity, southwestern Nova Scotia," was read by title. (See Transactions, page 67.)

On motion it was resolved that at the forthcoming state funeral of Sir Charles Tupper, Bart., the Institute be represented by its Council.

Second Ordinary Meeting.

Civil Engineering Lecture Room, N. S. Technical College, Halifax; 22nd February, 1916.

(The President, Dr. D. Fraser Harris, in the chair.)

The Recording Secretary reported what steps he had taken, under the resolution of the last meeting, to secure a place for the Institute in the state funeral of Sir Charles Tupper; but no such place had been assigned the society, and no definite reply had been received to his communication. The Institute, therefore, had been unable to attend in a body as had been intended.

The annual report of the Treasurer (Mr. Bowman), dated 6th Oct., 1915, was presented, showing that the receipts for the year ending 30th Sept., 1915, were \$269.00; the expenditures, \$34.30; and the balance on hand \$234.70; while the reserve fund balance was \$321.23. The report was received and adopted.

The Librarian's report, dated 9th Oct., 1915, was presented by Mr. Piers, showing that 1,803 books and pamphlets had been received by the Institute through its exchange list during the year 1914; and 913 had been received during the first nine months of the year 1915, namely January to September inclusive. The total number of books and pamphlets received by the Provincial Science Library (with which that of the Institute is incorporated) during the year 1914, was 2,848. The total number in the Science Library on 31st Dec., 1914, was 54,658. Of these, 39,417 (almost 72 per cent.) belong to the Institute, and 15,241 to the Science Library proper. Two hundred and forty-four

books were borrowed, besides those consulted in the Library. No binding or purchasing had been done. Since the outbreak of the present war in August, 1914, no publications have been received from societies or other institutions in the enemy's countries, or in the zone of military operations; and some societies with headquarters in districts affected, have announced that for the present they have had to cease publication. In sending out our Transactions, all societies in hostile countries have been omitted as recipients, as well as those within the zone occupied by the enemy. The report was received and adopted.

It was announced that the Transactions, vol. xiii, parts 3 and 4, and vol. xiv, part 1, had been distributed to members and others on the exchange-list.

The chair was taken by Dr. A. H. MacKay, and a paper was read on "The Beneficial Action of Certain 'Poisons'; and the Influence of Poisons on Protoplasm and on Enzymes respectively," by the president, Prof. David Fraser Harris, M. B., C. M., M. D., D. Sc., F. R. S. E., of Dalhousie University, Halifax. (See Transactions, page 96.) The subject was discussed by H. B. Vickery, C. B. Nickerson, Prof. Cameron, Dr. A. H. MacKay, and D. M. Fergusson.

Third Ordinary Meeting.

Civil Engineering Lecture Room, N. S. Technical College, Halifax; 10th April, 1916.

The First Vice-President, Dr. A. S. Mackenzie, in the chair.

John Cameron, M. D., D. Sc., F. R. S. E., professor of anatomy, Dalhousie University, Halifax, read a paper on "Some Recent Researches on the Anatomy and Psychology of the Ancient Egyptian of the Twelfth Dynasty."

THE ANATOMY AND PSYCHOLOGY OF THE ANCIENT EGYPTIAN. —By JOHN CAMERON, M.D., D.Sc., F.R.S.E., Professor of Anatomy, Dalhousie University, Halifax, N. S.

(Read 10 April 1916)

The wonderful civilization of Ancient Egypt has for long fascinated the writer. It is, however, only during the last eight years that a serious study of the language, manners and customs of this remarkable race has been undertaken, the stimulus to which was a request, in 1908, by Miss M. A. Murray of the Department of Egyptology, University College, London, to examine and make a report on the anatomy of two mummies belonging to a royal burial of the twelfth dynasty. One gets some idea of the immensity of time when one recollects that these personages had lived more than two thousand five hundred years before Christ, and had been buried before the advent of the biblical flood. They were, therefore, antediluvian. These presented so many remarkable features (some of which will be referred to in the course of this paper) that they stimulated the writer to undertake some further researches on the anatomy and mentality of the ancient Egyptian. The results of these are incorporated in the present communication.

Previous to the evolution of the civilization of Ancient Egypt the river Nile ran through a barren rockbound country on which authorities have estimated that nothing but primitive man could have subsisted. With reference to the exact period of time when civilization commenced and paleolithic man became annihilated in Egypt, remarkable data are provided by the rate at which the fertilizing Nile mud has been deposited in the Delta region. Geologists have demonstrated that in the Archaic Ages this mud was all poured directly into the Mediterranean. Borings in that area have disclosed the fact that the maximum thickness of this material is thirty-three feet, and as careful calculations have shown that the mud is deposited at the average rate of about four

inches for each century; by a simple calculation one can ascertain that the maximum period during which Egypt could really have existed as a habitable country is about ten thousand years, that is to say, from about 8000 B. C. As the written records of the country only begin with the commencement of the Dynastic Period—about 5000 B. C., very little is known about the Predynastic or Prehistoric Period, though one is furnished with proofs of its remarkable handcraft in the shape of beautiful alabaster jars of elegant design and workmanship. The burials of this period were also very characteristic, the body of the deceased being usually placed in its tomb in the attitude adopted by the unborn child in the womb, a fact which suggests that this early race believed in the existence of an after life; for the body was probably placed in this characteristic position so as to be ready for the rebirth, or in other words, the Resurrection.[1]

The culture, the art, and the learning of Ancient Egypt undoubtedly constituted the foundation of our modern civilization, and this fact alone affords sufficient justification for the study of this wonderful people. Indeed it was, in its way, of a higher order than the culture (spelt with a K) which a certain outlawed nation is in this year of Grace, 1916, trying to thrust upon the world by brute force. During the earlier dynastic periods, extending over 3800 years, from B. C. 5000 to B. C. 1200, the Israelites were slaves in Egypt. During the building of the great pyramids in the fourth Dynasty they were utilized, under the lash of their oppressors, to drag the vast blocks of stone up the long inclined planes which were erected, as the simplest means then known to the Egyptian engineers, to facilitate the placing of the blocks in position. There is some disagreement amongst authorities as to the exact date of the Exodus of the Israelites from Egypt. Some regard Merenptah, a pow-

1 This fact has been referred to by the writer in a recent paper. See the Canadian Medical Journal for May, 1916.

erful king of the nineteenth Dynasty, as the Pharoah of the Exodus; whilst others localize that historic epoch two or three Dynasties later. In any case, the Israelites had two or three thousand years in which to be influenced by the Egyptian civilization which they applied to good purpose in Palestine, and built up the stable fabric of the Jewish civilization. Another race which was strongly influenced by the Egyptian culture of the later Dynasties (from the 20th to the 30th) was the Ancient Greeks, and this interchange of art and learning between the two races was greatly facilitated during the Ptolemaic Period. After the death of Cleopatra, who was the last of the Ptolemies, in B. C. 30, the occupation of Egypt by the Roman conquerors enabled them also to obtain much benefit and inspiration from the Egyptian civilization.

The purpose of this lengthy introduction is to show that the Jewish, Græcian and Roman civilizations, which formed the foundation of European learning and culture, owed a great proportion of what was "brightest and best" to the wonderful inspiring influence of Ancient Egypt. It is declared by some that this wide-spread influence even reached far away Scotland, which is said to be named after Scota the daughter of one of the Pharoahs.

In regard to the physical anthropology of the ancient Egyptian, one of the most striking features I have been able to ascertain is their small stature. This seems remarkable when considered in conjunction with the warlike propensities of the race. All the mummies I have seen or examined have been those of short people. Indeed, the thing that strikes one on first examining a mummy is its remarkable shortness. As a result of my investigations, I have come to the conclusion that the average height of the Egyptian male adult could not have been more than 5 feet 3 or 4 inches, whereas, as you know, the average height of a man nowadays is about 5 feet 7 or 8. This, you will note, is a

considerable difference. There can, therefore, be no reasonable doubt about the fact that the human race is gradually getting taller. As a result, one can prophecy that in a few more thousands of years, if the present rate of progress is maintained, we shall find the world inhabited by a race of giants. I was so much struck with this idea that I made an examination of the wonderful collection of armour at the Tower of London, and was enabled to ascertain that many of the men of today would experience the greatest difficulty in donning one of these suits. It would thus appear as if the knights of old were not the splendid specimens of manhood one sees, for example, in the 85th Battalion, C.E.F., of which Nova Scotia is so justly proud. I do not know if environment has anything to do with stature, but I feel that emigration to a new land exerts some influence, for it was a pleasure to me to witness the magnificent physique of the members of the Australian Expeditionary Force, who, as you know, were the wonder and the admiration of everybody at the Dardanelles. In the official account of the military operations there, special reference was made over and over again to the amazing stature of the Australians, and I was much interested to note that Sir James Crichton Browne has recently suggested as an explanation that the children in Australia are brought up on a liberal amount of protein diet in the shape of beef and mutton, of which, of course, they possess an abundant supply. Physiologists are unanimous in their opinion that this is the most efficient form of diet for inducing a rapid and vigorous growth of young animal tissue.

Now the Ancient Egyptians appear to have indulged mainly in a cereal diet, as most of their animals were held sacred and were, on that account, not utilized for food to any great extent. This statement is borne out by the fact that the teeth in all the mummies I have examined were worn

absolutely flat, due, as all authorities declare, to the action of the millstone grit which got mixed with the flour during the process of grinding the corn. Thus a study even of the skeleton can provide us with a hint as to the nature of the diet of the individual. I should mention here that the teeth of Egyptian skulls, though often worn to an excessive degree, do not often exhibit decay or caries.

The capacity of the cranium of the ancient Egyptian, which is, of course, an excellent criterion as to the extent of the intellectual development of the individual, was found to be very high, as was to be expected in such a highly civilized race. The capacity of all the skulls measured by me was over 1450 c. cm. They were thus to be regarded as megacephalic, according to the classification of Flower, and indeed all compared favourably with the average cranial capacity of modern white races.

The cephalic index, though it is no criterion of mental capacity, proved of some interest. All the ancient Egyptian skulls I examined approached the index of 80, and therefore tended to be of the brachycephalic or broad-headed type. This is in striking contrast to the skull of British races, the average cephalic index of which is about 76 and thus approximates to the dolicocephalic or long-headed type. It may be of interest to you to note that the German skull tends towards the brachycephalic type, so that the present war might be regarded from the point of view of anthropology as a fight for supremacy and world domination between the long-headed and the broad-headed races.

The investigation of the important gnathic or alveolar index yielded interesting results. As you know, the human skull is specially distinguished from that of lower mammals by the vast expansion of the cranial portion, and a relatively feeble degree of development of the jaws. Therefore, in the lower races of mankind the jaws are strongly developed and project forward, as one would expect, such skulls being

described as prognathous. In the white races, on the other hand, the jaws are feebly developed while the frontal region is prominent—these skulls being termed orthognathous. The average alveolar index for the British race is in the neighbourhood of 96. Some of the ancient Egyptian skulls I examined were remarkably orthognathous, and, therefore, represented a very fine type, the index in one case being 93.8. This latter skull, which was that of the son of a prince, presented a high degree of evolution, the frontal region being particularly well modelled and intellectual in appearance. I was able, however, to find traces of negro admixture in many instances, one skull that I examined being strongly prognathous, with an alveolar index of 104.34, which actually exceeded in degree the average of the aboriginal Australian of today, which is 104, and is supposed to represent one of the lowest types of mankind.

Many other customs or habits of the Ancient Egyptians are shown by the condition of their skeletons. One of the most interesting of these is the effect produced by squatting on the bones of the lower limbs. Chairs or seats of any sort were a luxury in those days, so that the majority of people were compelled to use Mother Earth to sit upon. The result, as you will at once recognize, was to produce an extreme degree of flexion of the hip, knee, and ankle joints. You can study this posture for yourselves in the Egypt of today by walking along the streets of Cairo, where you will see the various vendors seated in a squatting position on the ground by the side of their wares. The result of this characteristic attitude is to cause the neck of the femur or thigh bone to press hard against the margin of its socket and the capsule of the hip joint, thus producing a smooth polished surface or facet on the front of the neck of the bone. The effect on the knee joint is to cause the upper end of the tibia or shin bone to become tilted backwards (retroversion) in order to adapt itself to the altered position of the limbs. In the erect

attitude of the body the upper end of the tibia ought, of course, to look directly upwards, in order to receive the weight of the body in the position of mechanical advantage. Again, the lower end of the tibia normally distributes the weight of the body to the foot by bearing vertically upon the upper surface of the astragalus. The effect of the squatting posture, however, is to thrust the front edge of the lower end of the tibia hard against the neck of the astragalus, thus producing a squatting facet on that part of the bone. The posture assumed by the individual during life can thus literally leave its indelible mark on the skeleton, and therefore even a close study of such apparently uninteresting things as bones can provide us with some instructive facts regarding the habits and mode of living adopted by their owner. These squatting facets were so excessively pronounced in some of the skeletons that I am inclined to think that these individuals had freely indulged in luxury and indolent habits.

One can learn much about the psychology of the Ancient Egyptians by studying the method of disposal of their dead. No subject has been discussed more freely than the reason why such very special means were taken to preserve the body from decay. The whole question is still of a very controversial nature, but the opinion which apparently possesses most weight nowadays is that each person possessed a spiritual double or *Ka*, the hieroglyph symbol for which is a very curious one. It is represented by a figure showing the arms raised above the head in the attitude of prayer or appeal, possibly for the future welfare of the deceased. The *Ka* was at liberty to leave the body of the deceased at death and might therefore possibly become reincarnated in another human being or even in an animal. In order to obviate the latter risk, which would have been manifestly serious, the body was preserved so that its *Ka* could return to it at any time of its own free will. For this purpose various inducements or attractions were provided for the *Ka* in the

shape of elaborate sepulchral furniture. For example, model boats with crews were provided so that the *Ka* could relieve the tedium of waiting by having a sail on the Nile which was quite near at hand, seeing that all the tombs were situated along its western bank, placed there, no doubt, in order to face the rising sun on the morning of the resurrection. Very frequently two boats were provided, the one for going down stream being simply supplied with oars whilst the one for travelling up the Nile against the current was a boat with the sail set. The transit of the *Ka* to or from the mummy was likewise encouraged and facilitated by painting false doors at intervals around the sides and ends of the coffin. In some cases these were actually made to open. In order, however, to ward off evil spirits from the deceased, the eyes of the hawk-headed god Horus, known as the Sacred Eyes, were painted on the coffin over the spot where the eyes of the mummy faced outwards. In the twelfth dynasty the mummy was usually laid on its left side and therefore the Sacred Eyes were placed on the side of the coffin opposite this point. Jars containing food, or models of slaves carrying food baskets were likewise provided for the use of the *Ka*, as was clearly explained on the body case of Khnumu-Nekht, a mummy of the twelfth dynasty which was unwrapped by Miss Murray and myself. Part of the inscription was in the form of a prayer that the god Osiris, would give "funeral offerings of bread, beer, oxen, fowls, clothing, incense, ointment, all things good and pure on which the god lives, for the *Ka* of the great uab-priest Khnumu-Nekht." There can thus be no reasonable doubt regarding the fact that the Ancient Egyptian believed not only in the existence of the after life, but also in the theory of reincarnation.

The process of mummification varied greatly throughout the dynasties, so that one was thereby enabled to locate the period to which the burial belonged by noting the means which were taken to preserve the body. For example the

mummies of the Ptolemaic Period were characterized by being embedded in bitumen or resin. The mummies of the twelfth dynasty investigated by Miss Murray and myself, were earlier in date than any that had been previously examined, so that we were eager to discover the mode of preservation and the chemicals used. From an analysis of the remains it was found that the chief materials employed were the chlorides, carbonates, sulphates, phosphates and silicates of potassium, sodium, calcium, and aluminium; in one case the chief substance employed being common salt, and in the other lime salts. The operation of embalming was apparently carried out as follows. The body was first eviscerated and then allowed to pickle in a solution of the above compounds for some time, at the end of which period the bandages were applied. It is astonishing to note the efforts that were made to preserve every particle of tissue. Each finger and each toe was carefully bandaged separately, and special means were taken to preserve even the nails which were held in position by being bound up with linen thread. Forty or fifty bandages for each mummy was a common average, some of these strips of cloth being ten yards or more in length, and their average width about four inches. This gives one some idea of the tedious work involved in the process of unwrapping. I well remember one mummy which gave two of us eight hours hard work. The bandages were all made of linen cloth beautifully hand-woven. This is rather remarkable in view of the fact that one of the greatest assets of modern Egypt is cotton, which, however, was apparently not introduced into Egypt until the Roman occupation.

The internal organs were separately embalmed and in many cases placed in four earthenware jars closed by a large wooden plug in the shape of a human head. I may mention here that the ancient Egyptians were great experts in the manufacture of pottery. These jars were termed Canopic

by the earlier Egyptologists, because they were supposed to resemble the god Canopus who was worshipped in Egypt in the form of a jar with a human head. The gods of the four cardinal points—north, south, east, and west—were delegated to safeguard the preservations of the internal organs, which were therefore placed in four jars—one for the lungs and heart, a second for the stomach and large intestines, a third for the small intestines, and a fourth for the liver and gall bladder. These jars were then placed in compartments in a beautifully decorated box called the Canopic Chest, on each side of which was a false door for the passage of the *Ka*. The contents of the chest were, as in the case of the coffin, rendered secure from all evil influence by painting the Sacred Eyes on each of the four sides of the box.

To many minds the idea of disturbing the dead may create a feeling of disapproval or even of repulsion, but I would like to say in justification of the act that the unravelling of the mysteries of long past ages can in most cases only be effected by studying the way in which primitive peoples disposed of their dead, as these are usually the only memorials of ancient civilization left to us to study in the absence of any written records. In this way one is provided with information not only regarding the mode of living, the manners and customs of these peoples, but also their mental outlook both on this life and on the life to come. No one, I think, will deny the fact that the information thus acquired is not only of the highest educative value, but also possesses the inestimable advantage of broadening our own mental horizon, and ought to stimulate us, fully armed as we are with all the advantages of a modern civilization, to higher and nobler achievements.

This paper was discussed by Dr. A. S. Mackenzie, H Piers, W. H. Prest, G. W. T. Irving, Dr. F. Woodbury, and Dr. E. Mackay.

Donald S. McIntosh, M. Sc., professor of geology, Dalhousie University, Halifax, read a paper entitled, "A Study of the Cow Bay Beaches, Halifax County, N. S." (See Transactions, page 109.) The subject was discussed by Dr. Mackenzie, H. Piers, and W. H. Prest.

Fourth Ordinary Meeting.

Civil Engineering Lecture Room, N. S. Technical College, Halifax; 10th May, 1916.

The President, Dr. D. Fraser Harris, in the chair.

In the absence of the writer, Carleton B. Nickerson, M. A., read a paper by Henry Jermain Maude Creighton, Dr. Sc., assistant professor of chemistry, Swarthmore College, Swarthmore, Penn., U. S. A., on "The Use of Soaps for the Absorption of Bromine Vapor." (See Transactions, page 120.) The subject was discussed by C. B. Nickerson, Prof. E. Mackay, Prof. Bronson, H. B. Vickery, D. M. Fergusson, and The President.

Lieutenant George Hugh Henderson, R. C. E., M. A., instructor in physics, Dalhousie University, Halifax, read a paper on "The Distribution of the Active Deposit of Radium in an Electric Field." (See Transactions, page 123.) The subject was discussed by Prof. Bronson, Prof. E. Mackay, and The President.

A paper by Alexander H. MacKay, LL. D., F. R. S. C., superintendent of education, Halifax, on "Phenological Observations in Nova Scotia, for 1915," was read by title. (See Transactions, page 133).

Harry Piers,
Recording Secretary.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1916-1917.

(Vol. XIV Part 3)

55TH ANNUAL BUSINESS MEETING.

Reading Room, N. S. Technical College, Halifax, 13th November, 1916.

THE PRESIDENT, PROF. D. FRASER HARRIS, in the chair.

Other members present: PROF. C. L. MOORE, PROF. E. MACKAY, DR. A. H. MACKAY, PROF D. S. MCINTOSH, C. B. NICKERSON, PROF. H. L. BRONSON, D. M. FERGUSON, W. L. BISHOP, PROF. A. G. NICHOLLS, W. H. PREST, and H. PIERS.

PRESIDENTIAL ADDRESS: (1) Obituary Notice; (2) The Man of Science in the Community Today.—By PROFESSOR DAVID FRASER HARRIS, M. B., C. M., M. D., D. Sc., F. R. S. E., F. R. S. C., Dalhousie University, Halifax.

(1) OBITUARY NOTICE.

Only one member of the Nova Scotian Institute of Science died during the past session. This was C. C. James, LL. D., C. M. G., who died suddenly while travelling on a tramway car, June 23rd, 1916. He joined this Institute in Dcember, 1896, as an associate member.

Charles Canniff James, M. A., Ll. D., F. R. S. C., C. M. G., was born in Napanee, Ont., in July, 1863, and was educated at Victoria University, Toronto. He was Professor of Chemistry at the Ontario Agricultural College, Guelph, from 1866 to 1891; in June of the latter year was appointed Deputy Minister of Agriculture and Secretary of the Bureau of Industries of Ontario; and more recently became the Dominion Commissioner of Agriculture. He was a fellow of the Royal Society of Canada, was made a C. M. G. in 1911, was president of the Ontario Historical Society, and has also occupied other prominent offices. He was well known as a lecturer and a contributor to magazines, and has written several books, and brochures on historical and literary topics, besides those on agricultural subjects. He was considered one of the best men in the public service of Ontario and possessed a thoroughly scientific knowledge of agriculture, combined with high talents of iniative and administration.

(2) The Man of Science in the Community Today.

Gentlemen:—Appalling beyond human comprehension as are the evils of this insanest of all wars, yet it cannot be denied that some measure of good is emerging distinctly from the welter. It is not too much to say that for the first time in the history of the British Empire, science is coming into her own. It is no doubt humiliating to have to confess that it was the misapplied science of our enemies which demonstrated to us how inferior was the place we had given science in our own national life. The land that produced Roger Bacon, Napier, Gilbert, Harvey, Newton, James Watt, Jenner, Faraday, Darwin, Kelvin, and Lister had to be shown by the exponents of science prostituted that science was nevertheless worth cultivating for its own sake.

Possibly nothing less terrific than this irruption of Teutonic

brutality would have shaken the British race out of its comfortable, mental inertia. But having been awakened, let us thankfully admit that our rulers are now doing something towards recognizing the all-prevading importance of science in the national life. Committees of various learned societies have been formed; the British Science Guild is taking action; the Royal College of science has recently presented a petition to Lord Crewe to have men of science adequately recognized, and the Government from early in the War has been consulting men of science on a large number of economic problems. Quite recently Sir J. J. Thompson has been elected chairman of an important committee to study the position of science in secondary schools and at the universities and its relations to trades, industries and professions which depend on applied science.

It cannot be denied that science, as science, has only very recently been allowed to have an independent existence in our national, intellectual system. The time is within the memory of some of us when the attempt to introduce laboratory teaching into the University of Oxford was met with a furious resistance; and when at length studies in practical chemistry were instituted they were alluded to as "stinks." History was repeating itself; for Leo Africanus, writing in the early part of the 16th century, thus described the chemical society of the learned Arabians at Fez: "There is a most stupid set of men who contaminate themselves with sulphur and other horrible stinks."

The attitude of Britain's premier University was in precisely the same spirit as that of the ex-priest Dupin who, on demanding the execution of Lavoisier, declared: "The republic has no need of chemists". This was in 1794, but fifty years later Oxford made it very clear that she too—and all that she stood for in English life—had no need of chemists or of any other kind of scientist. This was the

traditional mental attitude of educated Englishmen in the mid-Victorian era. The English gentleman knew no science, he did not want to know any, and honestly thought that neither did his country need to know any. We are all too apt to imagine that what we don't happen to care about is not worth other people caring about. The English gentleman certainly seemed to get on very well without science as countless ancestors had done before him; and where were there any gentlemen so perfect as those of English birth? He spoke, like one of the characters did in "Trilby", contemptuously of all foreigners as "damned". The French perhaps were his only rivals, and even in them he discerned faults, for did they not gesticulate when they spoke, and were they not wholly ignorant of sport? Without doubt, England's product par excellence was gentlemen. The public schools turned them out each year worthy of the high traditions of their forefathers. The English gentleman had his ancestral country seat in its beautiful timbered park, a haunt of ancient peace, for in all probability it was once an ivy-covered monastery; he had a rent roll so large that he never needed to soil his hands; but if he *did* want a profession for a younger son, were not the Church, the Navy, the Army, the Diplomatic Service, the Civil Service preferably of India, the Bar or lastly Politics all open to him? Everything else if not vulgar might be left to eccentric, beastly, long-haired foreigners—painting, sculpture, poetry, music. Literature as a profession was not to be thought of: of course it was respectable, for Macaulay, Lytton, and Beaconsfield had been it, and Scott was a gentleman; but really it was not "the thing". Of course there was the life of a 'Varsity Don, if by chance you were badly off and your son had brains—the life of a classical scholar was not vulgar; but the typical English gentleman didn't need University emoluments, and certainly didn't wish to assume University duties. The vast majority of University or School appoint-

ments were held by men who were already respectable for they were already clergymen. In the Army and Navy, whatever else he was, he was brave; but he left any science which those services required to those far beneath him, to those who were specially paid to bother about "beastly" technical details.

As regards the practice of Medicine, an applied science, he held exactly the same view as the ancient Roman who said that that was an occupation quite unworthy of a gentleman. But to do him justice, had this typical Englishman desired the profession of pure science, there was none for him to follow. The only professions he knew of were occupations descended from a remote antiquity—the church, fighting or the law—with all the prestige and privileges appertaining to things of such ancient lineage. I remember well, when, in the early nineties, I once filled up a form under the heading "Profession" with the word "physiologist," my father exclaiming, "But that's not a profession". He was perfectly right from his mid-Victorian point of view; it was not a profession in the sense that the Church, the Services and the Law are professions. Where were the ancient privileges, the social recognition, the pensions or fees for physiologists? Nowhere at that date, save as subjective potentialities. There was a day when it was true that the world had no need of physiologists. I was told the absolute truth when I was once informed that as far as my occupation was concerned with social recognition, I might just as well have been a hangman.

Science had not yet come into her own.

No doubt Governments have officially recognized such a science as Astronomy in the appointment of an Astronomer-Royal because of the enormous importance Astronomy has in its relations to navigation so especially important for a seafaring nation as the English have always been.

But, as we know, in course of time things changed. There was at last some science pure and applied, there was at last some exact knowledge to be known and taught; still it was not for gentlemen. It might be all very well for those who had to make engines and steamers and railways and bridges, but it was still not a profession; you dirtied your hands over it, and in particular, it was not taught at the only two Universities in England, for that godless institution(!!), University College, Gower Street, London, W. C., did not count at all.

One of the earliest national recognitions of pure science was the institution of the School of Mines in London, and later of the Royal College of Science now at South Kensington. The name of Huxley will always be associated with these institutions, as well as with drawing the attention of the British public to the existence of Science as a factor in the life of the community. He also brought to notice the dreadful inadequacy of the pay of the pure scientist. It is told in his biography how on one occasion he was asking some patron of an appointment he sought to vote for him, when this gentleman enquired, "But how much is the position worth after all?" "One hundred pounds," replied Huxley; "Good gracious," exclaimed the other, "I give more than that to my butler!" Precisely; we pay for what we most desire; we will pay for those who provide us with food and take care of our clothes—but pay scientists! No. Who are they in any case?—there is no such profession, day labourers' pay is good enough for them. But science grew for all that: "magna est veritas et prevalebit". Even gentlemen now touched the accursed thing. Did not the late Marquess of Salisbury have a private laboratory at Hatfield house; was not one of his nephews, F. M. Balfour, the Reader in Embryology at Cambridge; is not the Earl of Berkeley a physicist, and F. R. S.; is not Lord Raleigh at the present moment one of England's chief authorities

on physical science and an ex-President of the Royal Society to boot? Boyle of "Boyle's Law" was born in the purple, for he was the brother of the Earl of Cork; and was not the discoverer of Hydrogen gas, the Hon. Mr. Cavendish, a member of the noble house of that name, the Dukes of Devonshire?

Science then became at last at least respectable, even if it was not a profession. Doubtless there had always been a few respectable amateurs who cultivated pure science, for from them indeed under Kingly Patronage had the Royal Society itself actually sprung.

The instituting of degrees in Pure Science—B. Sc. and D. Sc.—by the University of London did a very great deal to foster the study of pure science in England and give it academic status. But in some nostrils at Oxford science still stinks; and it is still no profession.

When one says that the man of science is necessary to the national life, one generally thinks how science underlies the great trades and chemical manufactures, all the activities of our vastly complicated social system of railways, ocean transport, telegraphs, telephones, gunnery, aviation, and a thousand other modes of activity. But the man of science is as necessary to the national welfare in an infinitude of less conspicuous and more familiar ways.

We have all heard of scientific farming, the intelligent utilising of the resources of the soil in order to raise the largest crops of the best quality; but in very truth scientific knowledge underlies a proper understanding of so apparently simple a thing as marketing, buying the day's or the week's provisions.

The woman who knows that the nourishing value of twenty-five cents' worth of green leaves (so called salad) is not the same as that of twenty-five cents' worth of milk or eggs or beef is superior to her who has still to learn it by experience and indigestion. The light of Nature is by no means sufficient to show the purchaser of food what sort

of food will best support the body and yield it heat. There is a science of Food or Dietetics as surely as there is a science of Astronomy or Geology, and it is of much more consequence to "the man in the street".

Similarly Science underlies the practice of proper ventilation; a knowledge that the constant removal of bedroom air without a draught is necessary to health would save thousands of lives annually from being cast upon the void of tubercular infection. There is a science of Ventilation, first expounded and practised by an English church clergyman, the Rev. Stephen Hales, D. D., F. R. S., in the eighteenth century, but by no means understood today even by some most eminent architects. And does not science or exact knowledge underlie the choosing of clothes' stuffs and even the wearing of clothes? If, as Carlyle insisted, there is a philosophy of clothes, there is surely also a science of clothes. A knowledge of animal calorimetry will inform us as to the composition, weight, color, texture and much else of the clothes to be worn under varying conditions.

And so, too, science has something to say about such commonplace things as the duration of sleep proper to different ages of the child and of the youth; how the lack of it leads to inefficiency at school, how work before breakfast for school children is a physiological immorality. Science has something to say about the arrangment of hours of work and play in the school time-table, how fatigue of body and of mind can be recognized, prevented or cured, how the congenitally deficient child may be distinguished from the backward or merely lazy one. Science explains the significance of night-terrors, of growing pains, of headaches, of uncontrollable sleepiness in children; it has views on the games suitable for boys and girls at different ages; it supervises the gymnasium, the swimming-bath and the playing-field. The man of applied science, the physician, recognizes dilated heart, cardiac palpitation, and many of the significant

things arising from too much athletics which were overlooked by parents and teachers in the good old pre-scientific times.

Science in daily life, in so-called common life, is simply intelligent living—*the* great need of the community of today. The man of science has much to say about house-construction, house heating, drainage, sewerage and other technical problems deeply affecting the health of our cities on which "the light of Nature" throws very little light indeed.

I would go so far as to say that science has become the most important factor in the life of today. "But," some one may ask, "shall we not always need lawyers?" To which I would reply, that as long as human nature remains as it is, we shall always *have* lawyers, but we really *need* the man of science to guide us in crossing the unlit, uncharted desert of this world.

If any one is disposed to belittle science, I have an infallible cure; make him go through a day without the aid of anything that involved science in its discovery or making. Let such a person get up and try to light the fire; you cannot allow him matches, for phosphorus was discovered by men of science and is utilized by them in many ways. You could not allow him to wear clothes, for their fabrics were woven by a machine which was the result of scientific ingenuity applied to this very problem of weaving fibres into fabrics.

But we are not done with science in common life; it underlies the intelligent rearing of children, and prevents our giving them gastro-intestinal catarrh by allowing them a little of "whatever is going" which may range from gin to Welsh rarebit. The light of Nature gives a young mother instruction only up to a certain point as regards infant feeding. The man of science has developed Pediatrics.

Dust and flies have, in these recent days, come under the light of science, and this has shown them to be grave menaces to the well-being of the human race. A large number of serious, infectious, epidemic diseases are now

known to be insect-borne. Some of these are infantile gastro-enteritis, malaria, yellow-fever, typhus fever, typhoid fever, plague and the ophthalmia of hot countries.

Science has taught us what infection means, that it is not a vague, indefinable "principle", but a real, living, objective existence, ultra-visible, yet withal capable of being apprehended and sealed down under a microscope, of being recognized as specific, and lastly, happily able to be destroyed by sunlight, heat and certain chemical substances. It is sometimes said that science has added new terrors to our life; it has only done so when misused by the Hounds of Hell; it has rid our communities of those frightful scourges of the Middle Ages, Cholera, the Black Death and the Sweating Sickness, awful in the toll they took of human life, more awful still in their mysteriousness, for they came no man knew whence, and went, no man knew whither. But in the name of precise knowledge, science has arrested these grim spectres, their terrifying masks have been torn from them, and they have been revealed as the lowliest of the fungi, allies of the mushrooms and the moulds which prefer to live in darkness. The pestilence has been dragged into the light of noon-day, disarmed and conquered.

Science has added no terror to life; but it has rid us of the terror by night, of the pestilence that walketh in darkness. The night of ignorance is fast coming to an end, the bright dawn of the ampler day of exact knowledge is already bursting on the world.

And the man of science thinks of the future of the community; he sees it self-evident that one hundred sick and weakly children are not likely to grow up to be one hundred robust adults. He reflects that we take the greatest trouble to produce good strains of beef-cattle and milk-cows and dray-horses, prize cats, bulldogs, and canaries. We breed selectively with an end in view for the lower creation; but mankind must be left for evermore to breed by the light

of Nature: to suggest anything else is by some regarded as a eugenetical immorality. Still it is something to have got the length of admitting that there is a problem here at all.

Science is of the very warp and woof of the web of human existence; ought we not to reckon with it officially, as it is called? Has not the time come to *admit* that Science is as important as it really has become; for the existence of something and the official admission that it exists are two different things? Why should not science be taken under the care of a cabinet minister? It is no longer vulgar, it is no longer beneath the attention of the aristocratic intellect; it is of preponderating usefulness to the nation, and it is malevolent only when divorced from common-sense and common morality by the insane, megalomaniacal obsessions of self-hypnotized Prussians. It is within a very little of being even a profession! Why not recognize the pursuit of something which is almost a respectable profession, why not have the official interests and the economic aspects of science presided over by some one who knows something about them? There is much latent vulgarity in the public mind, and a great deal of snobbishness is endemic there.

Few people recognize worth at home or excellence in homespun; the familiar cannot be great, the prophet hath no honor in his own country. You must have things magnified out of their natural proportions, removed a little from the every day setting, to be appreciated by the public. To be quite specific; the man of science must have titles, orders, decorations before he is appreciated by the blind public. This is due to a weakness inherent in human nature. Prof. Soddy, F. R. S., writing in the "Glasgow Herald" about the beginning of August, 1916, said, Science must no longer be the "Cinderella". "There is a lamentable lack of intelligent interest in the sphere of Science as an essential factor in the education of the nation, as an indispensible instrument of its civilized progress. The unfortunate attitude

of the governing classes towards Science is largely the result of the monastic traditions of the great public schools and universities in which most of our leading politicians have been trained. We seek at this supreme crisis of our national history a man of clear vision and firm purpose who, taking all branches of knowledge for his province, will assign to each its true place and function in the education and training of all classes of the people. Such a man and such a purpose have yet to be achieved."

Science must no longer be subjected to anything approaching social ostracism. The man of science is just as entitled to "your excellency" as any diplomat, living or dead.

There has been a great deal of writing during the late summer on Science versus Latin and Greek; Science in the public schools and in the Civil Service, and on Science and Politics.

Prof. H. E. Armstrong says, "war has become a branch of Applied Chemistry, hence Germany's superiority." He goes on to say that Britain is governed primarily by and from Oxford. "If the horrors of the War do not cause Britain to reform, we shall be forced to confess that our chemical industries will silently fade away. Some years ago the necessity of reforming Oxford was generally recognized by those in the University and by outsiders. The resident staff advised the abolition of compulsory Greek, but the M. A.'s—the country clergy—arose and voted for the "status quo". Here we have Science versus class-inertia.

Professor Armstrong continues: "France, in 1871, admitted that she had been defeated by the Prussian schoolmaster." A writer in "Nature" wrote lately—"Our political leaders and administrators of state departments are trained in these classical schools where vested interests preserve the prime places for ancient learning. Science is discouraged for students who hope to obtain University scholarships or appointments in the highest rank of the civil serv

We need to make science the keynote of our public service and University system as Humboldt did early in the nineteenth century when Prussia was as yet under the heel of Napoleon. The peremptory necessity of better scientific organisation is apparent; it is not now only a question of our prosperity but of our existence.

The scientific mind and temper cannot flourish in an atmosphere of political trickery, nepotism and plunder such as we have. True science and politics are incompatible. They cannot exist together, any more than the eagle and the squid."

Science, in short, must have a Department, a Government office, before the public will fully accord it its place of honor. We may regret that this sort of thing has to be, but our regret will not change public opinion; and it appears to be part of the British Constitution that nothing can be done or should be done without a very large body of public opinion behind it. But the official recognition of science cannot wait until the public has seen fit to render science the homage it deserves. To begin at the top, let there be a Minister of Science and a Ministry of Science with just as much prestige accorded it as the War Office, the Foreign Office or the Home Office. The duties of the Minister of Science would be primarily to foster science in every way possible, to foster its interests, to administer its affairs somewhat after the manner in which the Board of Trade looks after trade, the department of Agriculture and Fisheries, agriculture and fisheries.

By friendly and intelligent co-operation with the Universities, Technical Colleges and the leaders amongst the manufacturers, the relations of science to the state could be adequately safeguarded; scientific men would be known, encouraged, subsidized, promoted, rewarded, and pensioned,

For why should state recognition, encouragement, promotion, and rewarding be reserved for sailors, soldiers,

diplomatists and lawyers? Why should it be so entirely correct to be paid for legal opinion, and such "bad form" to be remunerated for scientific advice? Because, you may rely, the Law is an ancient, respectable profession, and science is so modern that it is not a profession at all. But this mediaeval state of affairs cannot go on indefinitely; it was all very well for the day when there was no science to foster, and men quarrelled so much that lawyers were kept very busy, but now "nous avons changé tous cela"—or at least the earlier part of it. One need not here and now draw up an exhaustive list of the duties of the Minister of Science, but might merely remark that much that falls under the supervision of the Home Office could be transferred to the Department of Science. Had there been such a department, Edward Jenner, for instance, would not have had to struggle against every kind of obstacle and misrepresentation for as long a time as he did, or have had to wait as long as he had for the official recognition of what he had done for suffering humanity. Not from his own private house but from a Government department would the vaccine have gone forth to eager Europe. He truly called himself "The vaccine clerk of the whole world."

The first concern of the Science Office would be the place of science in the schools of the Empire. And here we come up againts the still burning question of the rival claims of Science and the Classics. Of course it ought to be perfectly possible to instruct boys in as much of Greek and Latin as would make them know the origin of the words in English derived from those languages, without necessarily making the boys read entire Greek and Latin authors in the original. The practice in the past of educating boys as though they were all going to be teachers of the classics is analogous to the teaching of Physiology to medical students as though they were allgoing to be professional physiologists. A very small minority of boys need to be able to write Latin

prose, far less verse, or even read Latin authors. Less than that is enough to enable them to know the derivation of words of classical origin, to explain some allusions to classical mythology, to pronounce the final "e" in Magdalene, Penelope, and Irene; and be able to write English with lucidity and without redundancy. Before this linguistic and literary instruction is ended, instruction in Natural Science should have begun, and should be continued long after the former is stopped We need not continue to teach boys Greek and Latin as in the days when there was little else to teach them; for in the meantime, such vast quantities of useful and essential facts have been brought to light. that we grudge all the time not devoted to the assimilating of them. It is usually supposed that because a boy knows some science, he will know no classics; and vice versa. I have never been able to see the necessity for this. Surely he can study some Science and yet know enough about Latin and Greek to enable him to understand what his scientific terms mean. But to expect any boy to attack no science until he has been made a classical scholar is ridiculous. The old method was virtually to set out to make everybody a classical scholar, and to end by making possibly one per cent. such. The other ninety-and-nine non-classically-minded persons, were made Latin-haters for the rest of their lives. The new method should be to teach all boys science, and let the one per cent. become classical experts if they desire it.

Outside the Arts Faculties of the Universities, there is no "market" for classical scholars; but there is a vehement and growing demand for persons who know something of all the sciences and everything about one of them.

Owing to our national physiological momentum, the teaching of boys has been continued on the same lines as those laid down by the educationists of the Revival of Learning in the Fifteenth Century. What Erasmus, Linacre and

Dean Collet planned was admirable for the day when America and printing had only just been discovered, but is possibly not so well adapted to the country which lights its cities by electric energy, speaks to America without wires, flies in high heaven like the eagle and descends to the abyss like a sea monster.

The Science Office will see to it that science receives official recognition in all entrance examinations whatsoever, and that it is not handicapped by receiving fewer marks than the classics or any other subject. Science must have her place in the curriculum not on suffrance or by-your-leave, but by right, and in virtue of its inherent dignity and usefulness. Science cannot any longer be the under-fed maid-of-all-work; Science is the Queen herself coming into her kingdom. Science is no longer to be merely permitted, tolerated, apologized for; she must preside at the Council Board because she already rules the lives of the people.

But it is not only the dead languages which take the place of the teaching of science in the schools. History, as often taught, is far too much the record of wars and of the immoralities of Royal Families. The struggle for freedom of thought is quite as important as that for political liberty. The History of the emancipation of a community from intellectual darkness is their real history. What do most people know of the history of Poland?—about what could be put on a visiting card; and yet they ought to know that Copernicus was a Pole, and a Doctor of Medicine, and that the title of his great book is "Revolutionibus orbium celestium", and the date 1543. The date 1543 is quite as important as 1314 or even 1066. In many cases the battles of history were not battles for liberty, but the outcome of childish quarrels between persons suffering from an inflated idea of their own importance.

The academic precedence of the Faculties, in which Theology, Arts, and Law come before Medicine and Science,

may still be tolerated at the old Universities as an interesting and significant relic of earlier times; but in all modern Universities, (as in the University of Birmingham from its foundation), Science is the Premier Faculty and takes the first place. The world advances not because of Church History or Homer or Virgil, but because of James Watt and Stephenson and Dalton, and Faraday and Harvey and Jenner and Darwin and Kelvin and Lister. Better fifty days of Faraday than a cycle of Aristotle.

This problem of the place of Science in pre-University education had better be settled once for all, because the present unsatisfactory state of matters is compromising our national efficiency. The modern community thinks that it is time to have its sons taught along lines other than those laid down by the Humanists of the end of the 15th century. It is rather ridiculous for boys to know something about Romulus and Remus, and a certain Balbus and his heaven-entreating, stained-glass attitudes, and about a few other persons who may or may not have existed before the Birth of Christ, and yet nothing whatever about the past, present or future of the world they live in or their own bodies and their mental and physical health. Anachronism of anachronisms, all is anachronism, saith the modern preacher.

It is Germany that has shown us national efficiency through science. But it is quite a mistake to suppose that those Germans who are so well trained in science are not also educated in the classics. Indeed it has recently been suggested in the British Parliament that the exhibition of German national immorality was due to their following Pagan instead of Christian lines of conduct. Personally, I think this is only part of the explanation; no Pagan writer with whom we are acquainted would have sanctioned the descent to those infra-human depths of cruelty which the Germans

have reached. The fact is that most of us Britons acquire the knowledge of any foreign language—dead or living—only with the greatest difficulty. It is not that the life of the ancient Greeks and Romans does not interest us, but since the way to it lies through the drudgery of acquiring a foreign grammar and vocabulary, we shrink from the distasteful task. The British difficulty in learning languages is in marked contrast with the Russian ease in this matter.

Closely allied to the subject of official recognition of men of science is that of the advisability of organizing the medical profession into a Department of Public Health, a Government Department with its medical officers, state-paid and state-pensioned. In other words, although preventive Medicine is state-controlled, curative Medicine is still the same old, unorganized, happy-go-lucky competition it ever was. Some thinkers assert that the time has now come for the appliced sience of curative medicine to be taken over by the state and organized into a system. Both departments—preventive medicine and curative medicine — would be under the Department of the Minister of Science. Naturally there would be but one portal of entrance with one uniform standard of entrance examniation into the Departments of Curative State Medicine and of Preventive State Medicine. The one uniform standard of entrance would remove a great many existing anomalies. The doctor would then be to the whole public what the club doctor is to a section of it. He would have to attend to the care of cases exactly like the M. O. H. attends to the prevention of cases. He would be a state official, salaried and pensioned as such. It is an anomaly if your child has scarlet fever that, while one aspect of the case can properly be taken in hand by an official only of the one aspect of medical science, the other aspect of the case has to be left to private medical enterprise. I should be able to summon a state-paid physician for a case of broken leg, pneumonia, or of insanity, just as I do one

for a case of measles or diphtheria. This would, of course, lead to the whole problem of medical treatment being solved by being state-controlled.

The great Hospitals, with their vast, beneficent out-patient departments, would become state institutions such as prisons, penitentiaries and asylums are already. There is no valid, other than a historical, reason why the scientific cure of disease should not be a state service as much as the scientific prevention of disease. The Indian Medical Service affords us an example of a state managed, medical service; it shows us how such an organization might be so vastly extended as to become imperial. Promotions, disability pensions, retirement pensions, etc. could be arranged for as in the civil service. The state would, therefore, also logically take up the problem of research in medicine, and directing it, co-ordinate the isolated efforts made in it in the manner most beneficial for the public weal. In the United States private enterprise has endowed medical research in a truly magnificent manner. Private endowments could still be given for medical research within the British Empire, but it would be well if the direction of medical research were made a responsibility of the State. Much of it is even now, as, for instance, the splendid work on plague done in India and the work on cancer in London. The medical researcher is a medical man no less than the general practitioner, he is only more specialized. He should be equally a servant of the state.

Let us now take the concrete case of the prospective student of Medicine, a youth of 16 or 17, to whom I have to teach Physiology. I want him to know something of the classics as well as something of science, and I should like him very much to know something of chemistry, physics and biology before I begin to explain to him the functions of the organs and systems of the human body. I particularly wish that he should know, for instance, the meaning

of the terms "vascular" as applied to the circulatory system, "neural" as applied to the nervous, and "digestive" as applied to the alimentary. I don't want to be asked at the end of a lecture what I meant by the expression, "the classical experiment". I should like my students to know already the meaning of such terms as blastoderm, somatopleure, placenta, hermaphrodite, metabolism, homogeneous and homodromous before they enter upon the study of Physiology at all. It is not a classical education that we object to, but an education that is practically exclusively classical, and often indeed does not impart the very information which is afterwards most needed. In fact, just as there should be chemistry for medical students, and physics for medical students, so there should be Greek and Latin for medical students. And if it be objected that this would not produce any measure of true culture, one would be tempted to ask whether the present system of preliminary education is producing a particularly cultured type of student; a visit to the theatre on "Students' Night" would hardly foster that impression.

A very useful alteration might be made in the teaching of mathematics to boys intended for the medical profession or studying for degrees in the biological sciences. A good deal of Euclidian Geometry might be cut out, and some instruction in the use of the differential calculus substituted. The use of logarithms ought in any case to be taught to all. But we who teach such a science as Physiology hope that the day is fast approaching when such instruction in the sciences introductory to Medicine will be given at school as will enable the student on entering the University to profit at once by teaching of University standard. This would reduce considerably the number of scientific subjects in the First Year of Medicine, and so lessen the load carried in that admittedly trying year.

Why, then, is a knowledge of science so useful to the

modern community? Apart altogether from the way in which science makes for technical efficiency, it is a means second to none in the training of the intellectual powers. In the first place it trains us in accuracy of observation, in reliability of drawing conclusions, in habits of precise thinking generally; and these are not small things.

Accuracy of observation! Some of us have not the faculty of observation at all. When we have observed, then comes the drawing of conclusions, the educing of laws from our data: this is none other than the age long quest for the causes of certain effects. Each science that is differentiated out of the mass of accumulated facts is one more specific example of the successful pursuit of the causes of phenomena. Is not each fresh case I have to see, one fresh problem in the applied sciences of medicine or surgery, an exercise in the connecting of certain signs with certain underlying causes or antecedents? To do this unerringly is not at all easy. Some say, "Oh, he is a good enough medical man, but he is no surgeon," as though anybody could be a physician. The proper relating of seen symptom with unseen condition is the problem of problems in medical diagnosis, and it requires the highest development of our powers of observation and of interpreting correctly the meaning of the data collected. The whole training of the medical student is towards this end; and in practical medicine you find as great a field for the exercise of scientific analysis and synthesis as in any of the other sciences. One has constantly to disentangle causes from causal conditions; causes from contributing circumstances, positive from negative factors, facts from opinions, and so on.

I am quite aware that there is a school of thought which objects to any one thing being called a cause; but this would be very troublesome if applied to practical medicine. One of the earliest things the student has to learn is to distinguish a fact from an inference about a fact, a phenomenon from

some one's opinion about it or explanation of it. This is much more difficult than it seems. How often are beliefs and views taken for facts!

Science teaches us to sift, discriminate, weigh, relate and assess. It trains us to investigate without personal or racial bias. One of the most monstrous assertions of the Germans is that all true science has been, is, and will be German.

Science is antagonistic to all mental laziness and all mental haziness. It is opposed to all tradition which cannot give a justification for its existence. Superstition flies before the light of science. Science impresses us with the dignity of facts; with the majesty of the inexorableness of law, the inevitableness of the bond between cause and effect, and the omnipresence of the principle of continuity. It does not allow us to accept the opinions of any man however exalted unless he can demonstrate them to us as derived from observed data by processes of reasoning similar to those used by all genuine students of science.

And thus, finally, we are led to recognize three orders or degrees in science,—

The collection of data;
The correlation of cause and effect;
The philosophy of science.

Facts must be observed, data collected, objects preserved and compared. Many men of science do not proceed beyond this first stage; they are often amateur "naturalists" who observe and collect much that is of great value. This is alluded to as "spade work" in science. Some one has to do it. Linnaeus did it, Roy did it, Darwin and Wallace did it. All the Anatomists, Embryologists, Zoologists, Botanists, Entomologists, Conchologists, Geologists, and Meteorologists are men of this lowest or first order of science. Theirs are the descriptive sciences. Some persons to-day

hold that all science is nothing more than description, when it goes beyond that it ceases to be science and has become—I am not sure what they say it has become.

Now, once we begin to use the collected data to "explain" things, we are beyond merely descriptive science, beyond empirical science, we have entered on rational science, the science of the second order. When at last we begin to speak of the Philosophy of Biology, of Embryology, and so on, we have arrived at science of the third or highest order.

Few men of science can voluntarily long remain engaged in science of the first order. Instinctively they ask, what do these things mean, what is the bearing of all this? Luckily most of us have that curiosity that cannot be satisfied with merely surveying specimens on shelves in a museum or columns of figures in a Blue Book.

There is so much that seems in need of explanation. Some hold that explanation is no business of the man of science. I believe it is his chief business. The veriest layman cannot be restrained from making his guesses into the meaning of what he has seen or heard. The man of science, too, makes his conjectures, his hypotheses to account for so-and-so. If right, other facts will be explained and the working hypothesis become a rational theory of the phenomena; but if wrong, he sets about forming another explanation. Darwin did a great deal of this sort of thing; in fact the Darwinian theory is an all-embracing explanation or correlating of an enormous number of apparently unrelated observations. Similarly Dalton's great work in chemistry was essentially the deducing of laws of the widest application from carefully ascertained experimental data. But examples need not be multiplied; it is of the essence of all Natural Science, for facts or objects by themselves are of no interest, no utility; they lead to nothing.

Once the working hypothesis has passed into the realm

of an established theory, then scientific prediction, one of the most fascinating exercises for the human intellect, can be indulged in. In these investigations the man of science is above considerations of personal tastes, individual predilections or considerations of race. He is above considerations of race, for science is international, in spite of the childish assertion of our enemies that all true science has been, is, and must be German. The true man of science cannot be jealous that his brother has discovered something which he has missed, because he is too happy in the solace of the reflection that a new fact has been born into the common consciousness of mankind.

The highest science of all flourishes in a very rare atmosphere, one not to be lived in without due preliminary acclimatization. It is the realm of the Philosophy of Knowledge. Not merely what facts mean or even what generalizations can be framed upon them, but existence in itself, is what is studied here. This highest of all science examines everything that is fundamental in the constitution of things, and it includes the mind of man himself as one of the objects of the most careful study.

Science of the First order deals with Facts, Science of the Second order with Knowledge, Science of the Third order with Truth.

The Man of the third order of science—the reverent philosopher—aspires to a far more searching analysis, to a very much more comprehensive view of things than that which merely gives him natural law in the physical world. He is striving towards an ideal in knowledge, towards a form of wisdom which is the result of critical investigations in the realm of the most abstract forms of thought.

Science of the first order may measure the duration of a phenomenon in terms of seconds, science of the second order may attempt to explain why a phenomenon occupied the duration of seconds and not minutes or hours; but

science of the third degree asks, "What is time itself"? Is it a thing in itself or is it a Kantian category of the understanding, a conceptual relationship involving simultaneously the consciousness of the enduring ego along with the unconsciousness of the non-ego?

The man of the third degree of science asks what nexus, if any, is there between cause and effect; what is the relationship of antecedent to subsequent; what is matter, force, energy, yea, even what are time and space; what, in fact, are axioms, what are self-evident, truths, and so forth?

Science of the third degree may be called the Philosophy of Science, but not called Metaphysics, since that term denotes an intellectual outlook which is thoroughly obsolete. "Supra-material science" might be a less objectionable name. But when we call it "philosophy" we do not mean thereby something which thinks itself above all so-called empirical science, and which looks down on natural science as a gross thing belonging to a lower world.

The man of this highest science is merely the thinker passing from things to the relationships and meanings of things.

If "the undevout philosopher is mad," the unscientific philosopher is sterile; and better anything than intellectual sterility.

The goal of the highest science is the comprehension of the True and the Beautiful as only two different aspects of that supreme knowable, the intelligible cosmos.

Great is science and it will prevail. Let us not listen to people who tell us that science destroys poetry, the aesthetic sense, reverence or religion.

The day of the materialistic, unpoetical, unlovely, omniscient scientist is gone, we hope, for ever. The poetical man of science is certainly a possibility: he has come; and seen and conquered the absurd notion that the poetical outlook is incompatible with the scientific. "Proud philo-

sophy" and "cold science" belong to the eighteenth, not to the twentieth century.

The tints of the rainbow are not less but more beautiful to the physicist because he knows how they come to be there, and why in that particular order. Keats' lament that Newton, by explaining the rainbow, had taken the poetry out of it, means merely that Newton had taken the poetry out of the rainbow for Keats.

The lily-of-the-valley will smell quite as sweet to me even though I may live to see the day when its odor-producing substance has been identified, extracted, and named by the chemist. The man of science can be as sensitive as the veriest artist in presence of the beauty of coloring or of outline, even although he *is* able to explain the source or origin of them both.

The man of science is not the less sensitive to physical beauty which appeals to the senses because he happens also to know of another order of beauty which appeals to the intellect.

It is some time since true men of science jeered at religion. For, for some of them, what is called "religion" is one more mental phenomenon they are called upon to explain. The complete man of science is not only a poet, he is a reverent poet. The prayer of the lisping child, no less than the profoundest abstraction of the philosopher, is worthy of his study.

Why is life so vapid for so many? Because they know neither facts nor the explanations of facts. They know not the wonder, the beauty, the richness, or the variety of Nature's treasures. Culture is too often thought of as a state of mind which is the outcome of a knowledge of some of the expressions of Art; it is very rarely imagined as due to the possession of the scientific temperament. But culture is really not so much the result of the possession of knowledge,

as an attitude of mind or disposition, a sympathetic attitude of mind towards all mental products and intellectual interests.

The study of science is in many cases able to confer a truer culture than half a life-time spent in studios or around pianos. Your painter or musician *may* be a perfect barbarian, ignorant, superstitious, self-satisfied, and intolerant. There need be no fear of allowing science to be freely taught. Not science, but a hideous, perposterous, soul-destroying ethic it is, that has made the Germans what they are to-day. Science without a love of the beautiful, without respect for the past, without poetry, without sympathy, without reverence is the most repulsive product of the mind of man.

Such is the science of our enemies; and it has led them into the bottomless pit of national suicide. But such truly is science falsely so-called.

Science, the true, is the patient, loving interpretation of the world we live in; it is a striving to attain not merely to an understanding of the laws whereby the world is governed, but to the enjoyment of the beauty and order which is everywhere revealed. And the minds of men capable of attaining to such heights of appreciation, and the evidences around us of an all-prevading personality are only so many additional phenomena to be apprehended as constituent elements of that vast, sublime, age-enduring cosmos which we call the Universe.

After remarks by Dr. Bronson, Dr. E. Mackay, Dr. A. H. MacKay, and Mr. Piers, it was resolved that additional copies of the President's address be printed for early circulation.

The annual report of the Treasurer, Mr. Bowman, was presented. It showed that the receipts for the year ending 30th September, 1916, were \$364.70, the expenditures \$129.30, and the balance in current account \$235.40. The report having been audited, was received and adopted.

The librarian's report, dated 11th October, 1916, was presented by MR. PIERS, showing that 1,278 books and pamphlets had been received by the Institute through its exchange-list during the calendar year 1915; and 981 had been received during the first nine months of the present year (1916), namely January to September inclusive. The total number of books and pamphlets received by the Provincial Science Library (with which those of the Institute are incorporated) during the year 1915, was 1,731. The total number in the Science Library on 31st December, 1915, was 56,389. Of these, 40, 695 (about 72 per cent.) belong to the Institute, and 15,694 to the Science Library proper. 139 books were borrowed in 1915, besides those consulted in the Library. No binding or purchasing has been done by the Library directly.—The report was received and adopted.

On motion of MR. PIERS and DR. A. H. MACKAY, it was unanimously resolved that this society express its regret at the illness of MR. MAYNARD BOWMAN who is one of its oldest members, and its appreciation of his services as treasurer for the past nine years.

The following were elected officers for the ensuing year (1916-17):

President,—PROFESSOR DAVID FRASER HARRIS, M. B., C. M., M. D., B. SC. (LOND.), D. SC., F. R. S. E., F. R. S. C., *ex officio* F. R. M. S.

First Vice-President,—PRESIDENT ARTHUR STANLEY MACKENZIE, PH. D., F. R. S. C.

Second Vice-President,— PROFESSOR CLARENCE LEANDER MOORE, M. A., F. R. S. C.

Treasurer,—[GEORGE W. T. IRVING appointed 12th Dec. 1916.]

Corresponding Secretary,—PROFESSOR EBENEZER MACKAY, PH. D.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,—ALEXANDER HOWARD MACKAY, LL. D., F. R. S. C.; PROFESSOR DONALD SUTHERLAND McINTOSH, M. SC.; CARLETON BELL NICKERSON, M. A.; PROFESSOR HOWARD LOGAN BRONSON, PH. D.; WILLIAM HARROP HATTIE, M. D.; PROFESSOR JOHN CAMERON, M. D., D. SC., F. R. S. E.; and PROFESSOR ALBERT G. NICHOLLS, M. D., D. SC., F. R. S. C.

Auditors,—GEORGE W. T. IRVING and DONALD M. FERGUSSON, F. S. C.

Owing to MR. BOWMAN's illness it was decided to appoint a treasurer to succeed him, and it was resolved that the council nominate a suitable person for the office and report to the next ordinary meeting for approval.

FIRST ORDINARY MEETING.

Reading Room, N. S. Technical College, Halifax, N. S.; Monday, 13th November, 1916.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

The first ordinary meeting of the session was held on the conclusion of the Annual Business Meeting.

A paper entitled "A New Evening Primrose (*Œnothera novae-scotiae*)," by REGINALD RUGGLES GATES, PH. D., F. L. S., sometimg Lecturer in Biology and Cytology in the University of London, Eng., and just now of New York, was presented by DR. A. H. MACKAY. (See transactions, vol. XIV, pt. 2, p. 141. A vote of thanks was passed to DR. GATES for his communication.

SECOND ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, N. S.; Tuesday, 12th December, 1916.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

It was reported that the council had, on 30th November, elected the following members:—ROBERT MATHESON, PH.

D., assistant professor of economic entomology, Cornell University, Ithaca, N. Y., U. S. A. (corresponding member); REGINALD RUGGLES GATES, PH. D., F. L. S., sometime lecturer in biology and cytology, University of London, Univ. of London Club, London, W. C., Eng., (corresponding member); and WILLIAM WEATHERSPOON WOODBURY, B. Sc., D. D. S., Spring Garden Road, Halifax, (ordinary member).

On motion of MR. PIERS and DR. A. H. MACKAY, GEORGE W. T. IRVING, of the Education Office, Halifax, was duly appointed Treasurer to succeed MR. BOWMAN who is ill.

A letter from MR. BOWMAN, dated 11th December, was read, thanking the society for its resolution of 13th November, and expressing appreciation of the courtesy received during the years he had acted as librarian and treasurer.

A paper entitled "A Comparative Study of the Piltdown, Cro-magnon, and Neanderthal Skull," was read by JOHN CAMERON, M. D., D. Sc., F. R. S. C., professor of anatomy, Dalhousie University, Halifax; the lecture being illustrated by lantern slides.

The subject was discussed at considerable length by the PRESIDENT, who presented a chemical note on the relation of men to monkeys; and also by PROF. MCINTOSH, DR. A. H. MACKAY, MR. IRVING, MR. PIERS, DR. BRONSON and PROF. C. J. CONNOLLY of Antigonish.

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, N. S.; Monday 12th March, 1917.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

PROF. E. MACKAY reported that a committee appointed by the council, and consisting of the PRESIDENT, DR. MACKENZIE and himself, had interviewed the Premier of the Province and urged that the grant to the Institute be continued, and furthermore requested that an adequate addition

be made to the grant in lieu of the grant which had been suffered to lapse in a past year. The Premier while recognizing the needs of the Institute and being in sympathy therewith, nevertheless felt that it would be very difficult to enlarge the grant as it appears in the estimates.

Dr. A. H. MacKay took the chair while Dr. D. Fraser Harris, read a paper on "The Physical Condition underlying the Varieties of Common Sensation." The subject was discussed by Dr. A. H. MacKay, Dr. E. MacKay, D. M. Fergusson, H. B. Vickery and Dr. A. G. Nicholls.

It was reported that on 5th January the council had elected as an ordinary member, Charles C. Forward of the Laboratory of the Inland Revenue Department, Halifax.

Fourth Ordinary Meeting.

Physiological Lecture Room, Dalhousie College, Carleton St., Halifax, N. S.; Monday 14th May, 1917.

The President, Dr. D. Fraser Harris, in the chair.

On motion of Mr. Piers and Dr. A. H. MacKay, the following resolution was unanimously adopted:—

The Nova Scotia Insitute of Science learns with deep regret of the death of its past president, Henry Skeffington Poole, D. Sc., Assoc. R. S. M., F. G. S., F. R. S. C., which occurred at his residence, "Spreyton," Guildford, Surrey, England, on the 31st of March, 1917, at the age of seventy-two years. Dr. Poole who was the only son of a foundation member, joined the Institute on 11th November, 1872, when Inspector of Mines, and was one of its oldest active members. He occupied with dignity the presidential chair from November, 1902, to October, 1905. He was an able geologist and mining engineer, devoted special attention to the coal-measures of Nova Scotia, on which he was an acknowledged authority, and his writings have added much to our knowledge on this subject. All who came into personal contact with him bear witness to his fine qualities as a man.

The Institute of Science also desires to place on record its sense of the loss which it and the cause of education have sustained through the death of its former president, ALEXANDER McKAY, M. A., late supervisor of public schools, Halifax, which took place at Dartmouth, N. S., on 8th April, 1917, at the age of seventy-five years. Mr. McKay joined the society on 5th February, 1872, and was its oldest active member. He was recording-secretary from 1886 to 1894, and president from November, 1897, to November, 1899. While not actually engaged in scientific research himself, he always took keen interest in all work related to science in this province. His name will be long remembered for his great service in the cause of education.

HUBERT BRADFORD VICKERY, B. Sc., science master, Bloomfield High School, Halifax, read a paper on "The Isochlors of Western Nova Scotia." The subject was discussed by DR. A. H. MACKAY, DR. H. D. BRUNT, H. PIERS, D. M. FERGUSSON, PROF. L. C. HARLOW (Truro), PROF. E. MACKAY, and PROF. D. S. MCINTOSH.

The following papers were read by title:—

(1) "Phenological Observations, Nova Scotia, for 1916."—by A. H. MACKAY, LL. D., F. R. S. C., superintendent of education, Halifax. (See Transactions, p. 147).

(2) "Notes on the Birds of the Grand Pré Region, Kings Co., Nova Scotia."—By ROBIE W. TUFTS, Wolfville, N. S. (See Transactions, p. 155).

(3) "The Orthoptera (Cockroaches, Locusts, Grasshoppers and Crickets) of Nova Scotia; with descriptions of the species and notes on their occurrence and habits."—By HARRY PIERS, curator of the Provincial Museum of N. S., Halifax. (See Transactions, p. 201).

A vote of thanks was passed to MR. TUFTS (non-member) for his paper.

HARRY PIERS,
Recording Secretary.

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1917–1918.

(Vol. XIV Part 4)

56TH ANNUAL SESSION.

ANNUAL BUSINESS MEETING.

Civil Engineering Lecture Room, N. S. Technical College, Halifax, 10th October, 1917.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

Other members present: DR. E. MACKAY, DR. A. H. MACKAY, DR. H. L. BRONSON, PROF. D. S. MCINTOSH, D. M. FERGUSSON, C. B. NICKERSON, DR. J. CAMERON, G. W. T. IRVING, H. B. VICKERY and H. PIERS.

It was announced that Dr. Edward Blackadder, Halifax, has been elected an ordinary member on 26th September, 1917.

PRESIDENTIAL ADDRESS: by DR. D. FRASER HARRIS.

Speaking *extempore* the President referred to the general work of the Institute during the past year, its prospects for the present year, and called attention to the loss of two eminent members of whom brief biographical sketches follow:

Alexander McKay, M. A., passed away at his home in Dartmouth on 8th April, 1917. He became a member of the Institute, 5th Feb., 1872, and for the most of the time thereafter was an active member of the Council. He was Recording Secretary for twelve years—from 12 Oct., 1881 to 12 Nov., 1894, except during the year Oct., 1885 to Oct., 1886; and was President from 8 Nov., 1897 to 20 Nov., 1899. The following brief sketch of his remarkable career as one of Nova Scotia's greatest educationists is from the *Journal of Education*, April 1917;—

"He was born at Earltown, Colchester County, 16th July, 1841; commenced teaching in Pictou County, 1856; graduated from the Normal School at Truro after two sessions, in 1859. He taught thereafter in the counties of Digby, Colchester and Kings, resigning the principalship of the Wolfville schools in 1872 for the principalship of the Dartmouth schools.

"In 1881 he was appointed to the department of mathematics and science in the Halifax County Academy; and in 1884 became Supervisor of the Halifax Schools which position he resigned at the end of 1916 owing to illness.

"He filled many other responsible positions simultaneously. As Advisory Commissioner for Nova Scotia, he installed the Provincial Education Exhibit at the World's Fair in Chicago, 1893; and in 1902 was appointed by the Provincial Government as a member of the Acadian Commission. He filled for many years such positions as Director of the Victoria School of Art and Design, Director of the Halifax Ladies' College, member of the Provincial Exhibition Commission, Secretary of the Provincial Education Association for about forty years, Lecturer in the first Technical Institute of Halifax in the seventies of last century, Lecturer in Education in Dalhousie University, President of the Summer School of Science, President of the Nova Scotian Institute of Science, President of the Temperance Alliance, a Provincial Examiner in Drawing and Educational Subjects.

"No citizen had been more actively and usefully interested in public affairs. The Halifax School Board raised a monument to his memory while he was yet living in the fine Alexander McKay School."

Henry Skeffington Poole, D. Sc., F. G. S., F. R. S. C., was born at Stellarton, Pictou County, Nova Scotia, 1 August, 1844, and was a son of Henry Poole, a well-known mining engineer of this province. He graduated from King's College, Windsor, as B. A. in 1865, as M. A. in 1874, and as D. Sc. in 1903; and became an associate of the Royal School of Mines, London.

As an eminent mining engineer he directed coal mining in Cape Breton, and silver mining in Utah, U. S. A. He was appointed inspector of coal mines in Nova Scotia from 1872 to 1878. He then became chairman of the Board of Examiners for Mining Certificates and general manager of the Acadia Coal Company from which he retired with a distinguished testimonial in 1901. He was president of the Mining Society of Nova Scotia, a member of the Canadian Society of Civil Engineers, a Fellow of the Royal Society of Canada, a Fellow of the Geological Society and a member of the Federated Institute of Mining Engineers. He was a contributor to various scientific and technical journals, to the reports of the Canadian Geological Survey, the Journal of the Geological Society, and especially to the Transactions of our Nova Scotian Institute of Science, the last contribution being on "*Senecio Jacobaea and Callimorpha Jacobaea* (The Cattle-Killing Ragwort and the Cinnabar Moth)" which will be found at page 279 of Volume XIII (Session of 1913-1914).

He became a member of the Institute of Science on 11 Nov., 1872, and was its President from 24 Nov., 1902 to 18 Oct., 1905. He retired to England, thereafter, where he died on 31 March, 1917, at his home in Guildford, Surrey.

The Treasurer, Mr. Irving, presented his annual report, showing that the receipts for the year ended 30th Sept., 1917, were $810.40; the expenditure, $383.40; and the balance on hand, $427.00.—The report was received and adopted.

The Librarian's report was presented by Mr. Piers,
3 showing that 1,369 books and pamphlets had been received through the exchange-list during the year 1916; and 841 have been received during the first nine months of the present year 1917, namely January to September inclusive. The total number of books and pamphlets received by the Provincial Science Library (with which that of the Institute is incorporated)

during the year 1916, was 1,586. The total number in the Science Library on 31st December, 1916, was 57,975. Of these, 42,064 (about 72½ per cent.) belong to the Institute, and 15,911 to the Science Library proper. 126 books were borrowed in 1916 besides those consulted in the library No binding or purchasing has been done by the library directly, there being no money grant at its disposal.—The report was received and adopted.

The Council reported that on 26th September it had sent a resolution to the Dominion Premier and the Minister of Militia and Defence, requesting that in applying the Military Service Act very special efforts be made to ensure that such technically trained men as may be enlisted be drafted into that particular branch of the service for which they are most nearly fitted by their training and experience in civil life. Replies had been received, stating that the Institute's representation would have due consideration.—The Council's action was approved by the meeting.

Some discussion took place on a subject referred to in the President's address, and it was resolved that the question be announced as a subject for discussion at the next ordinary meeting, viz., Whether the Transactions be more particularly confined to the publication of papers on subjects bearing more or less directly on Nova Scotia, except in such non-local departments as chemistry and physics, as has been the practice in the past; or whether the publication of papers on non-local subjects generally be permitted.

The following gentlemen were elected officers for the ensuing year (1917-18):

President,—PROFESSOR DAVID FRASER HARRIS, M. B., C. M., M. D., B. Sc. (LOND.), D. Sc., F. R. S. E., F. R. S. C., *ex offiico* F. R. M. S.

First-Vice President,—PRESIDENT ARTHUR STANLEY MACKENZIE, Ph. D., F. R. S. C.

Second Vice-President,—PROFESSOR CLARENCE LEANDER MOORE, M. A., F. R. S. C.

Treasurer,—GEORGE W. T. IRVING.

Corresponding Secretary,—PROFESSOR EBENEZER MACKAY, Ph. D.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,— ALEXANDER HOWARD MACKAY, LL. D., F. R. S. C.; PROFESSOR DONALD SUTHERLAND MCINTOSH, M. Sc.; CARLETON BELL NICKERSON, M. A.; PROFESSOR HOWARD LOGAN BRONSON, Ph. D.; WILLIAM HARROP HATTIE, M. D.; PROFESSOR JOHN CAMERON, M. D., D. Sc., F. R. S. E.; and PROFESSOR ARTHUR G. NICHOLLS, M. D., D. Sc., F. R. S. C.

Auditors,—DONALD M. FERGUSSON, F. C. S., and HUBERT B. VICKERY, B. Sc.

FIRST ORDINARY MEETING.

Physiological Lecture Room, Dalhousie Medical College, Carleton Street, Halifax, 11th February, 1918.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

Other members present: DR. A. H. MACKAY, DR. E. MACKAY, DR. J. CAMERON, PROF. MOORE, PROF. MCINTOSH and MR. PIERS.

As H. B. VICKERY was out of town, the reading of his paper on "Isochlors of Nova Scotia, part 2," was deferred to a later meeting.

DR. J. CAMERON then took up his motion, of which due notice had been given at the last Annual Meeting; to the effect that the Transactions of the Institute be thrown open to any

scientific paper, even if not on a subject bearing on Nova Scotia. The motion was seconded by DR. A. H. MACKAY and supported by DR. E. MACKAY and PROF. MOORE. MR. PIERS opposed the motion, holding that the Transactions, as has been the ruling practice in the past, should continue only open to papers dealing more or less distinctly with Nova Scotian subjects, except in such essentially non-local departments as physics, chemistry, physiology, etc.; other non-local papers, when deemed worthy, being printed in the Proceedings.

DR. CAMERON finally modified his motion to read thus:—"Resolved that the N. S. Institute of Science throw open its Proceedings and Transactions to papers in all departments of science, provided they are contributed by persons working in Nova Scotia." The motion passed, MR. PIERS dissenting if the motion was construed as authorizing the publication in the Transactions of communications having no local bearing, except in the case of such subjects as had been previously referred to.

SECOND ORDINARY MEETING.

Physiological Lecture Room, Dalhousie Medical College, Halifax; 11th March, 1918.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

H. B. VICKERY, read a paper entitled "The Isochlors of Nova Scotia, part 2." (See Transactions, page 355).

WALTER H. PREST, read a paper "On the Nature and Origin of the Eskers of Nova Scotia." (See Transactions, page 371). The subject was discussed by PROF. MCINTOSH, DR. A. H. MACKAY, H. B. VICKERY and DR. E. MACKAY.

Special Meeting.

Legislative Council Chamber, Province Building, Halifax 13th May, 1918.

The President, Dr. D. Fraser Harris, in the chair.

Among those present were: His Honor the Lieut.-Governor and Mrs. Grant, President A. S. MacKenzie, Prof. E. MacKay, Dr. A. H. MacKay, Prof. H. L. Bronsob, C. B. Nickerson, Maynard Bowman, Capt. John Read, Mrs. Read, the Misses Read, Mrs. A. H. MacKay, Mrs. E. D. MacAvity, Mrs. A. Lawson, H. Piers, and other.

President D. Fraser Harris, speaking from the Chair, said:

"Your Honor, members of the Nova Scotian Institute of Science, ladies and gentlemen:

The Institute is fortunate in having acquired, through the generosity of a friend who wishes to remain unknown, a portrait of the late Professor J. Gordon MacGregor, a former President of this Institute. The portrait, which is about to be unveiled, was painted by the well-known artist, Mrs. E. D. MacAvity.

This evening we are further particularly fortunate in having with us the nearest male relative—a nephew— of the late Professor MacGregor, in the person of Capt. John Read, whom I shall ask in a few minutes to unveil the portrait. We hail this opportunity of welcoming Captain Read back to his native land after his period of active and honourable service against an active and dishonourable foe.

But we are also able to congratulate ourselves on having with us this evening a former student of Professor MacGregor, Dr. A. Stanley MacKenzie, President of Dalhousie University who will presently tell us something of the scientific life and

work of the late Professor MacGregor, work for which, as we all know, there was conferred on him the Fellowship of the Royal Society. I confess that I, for one, do not know which of his researches won for MacGregor that blue ribbon in Science: but I hope President MacKenzie will tell us about this, for I believe that there has been no public acknowledgement of the work and position of MacGregor since his death, if we except an obituary notice of him which appeared in the Transactions of this Institute.

I remember well MacGregor being elected to the Chair of Natural Philosophy at the University of Edinburgh, a chair made illustrious by its having been held by Sir John Leslie early in the 19th century and by Peter Guthrie Tait in our own day. Dr. MacGregor was one of the last men of science of whom I took farewell in November, 1911, a few days before I sailed for Canada. When I called on him, though he was evidently busy, he showed me over the department which had been provided for him out of the building that was formerly the Edinburgh Royal Infirmary. The famous "old Royal," the Infirmary of the second Monro, of Syme and of Lister; the Infirmary where Henley the poet lay convalescing when he wrote those virile lines on his surgeons and nurses.

Knowing that I had just come from St. Andrews, the home of the illustrious academic family of the Hunters,—my wife's family,—to which Sir John Leslie was related, MacGregor drew my attention to the instruments, carefully preserved, which Leslie had used. There, reverently preserved in a kind of museum, were his hygrometers and differential thermometers and other apparatus with which Leslie investigated the phenomena of the production of cold by artificial congelation, or "Leslie's phenomenon" as it is sometimes called.

Professor Tait, MacGregor's immediate predecessor, was my own teacher in physics. MacGregor told me something

about Halifax and about Dalhousie, and gave me kind advice. I left him to pay two more farewell calls; all three of those from whom I parted that day have since crossed the dark river.

I crave the pardon of this gathering if I have introduced too personal a note into these remarks; but if I have, it is probably due to my drawing near to that period of life which has been called one's "anecdotage."

I shall now ask Capt. Read to unveil the portrait."

Captain Read, after unveiling the portrait amidst applause, said how highly he appreciated the honor which the Institute had done him in asking him to unveil this fine likeness of his distinguished relative.

The President of the Institute then called upon the President of Dalhousie University to read his appreciation of the scientific work of the late Professor MacGregor.

James Gordon Macgregor

By A. S. Mackenzie, Ph. D., F.R.S.C., President of Dalhousie University.

This does not pretend to be a life of MacGregor, nor a proper appreciation of him as a scientist, but merely some hastily gathered facts, and some recollections and an opinion or two.

First of all a few dates, etc.—

1852 Born at Halifax, March 31st,—son of Rev. P. G. MacGregor. Educated at Free Church Academy, Halifax.

1867 Entered Dalhousie College, winning the Entrance Scholarship.

First Year: 1st prizes in Classics and Mathematics. 2nd prize in Elocution.

Second Year: 1st prizes in Classics, Mathematics and Logic and Psychology.

Third Year: 1st prizes in Classics and Natural Philosophy.

Fourth Year: 1st prizes in Classics, Ethics, History and Modern Languages. Sir William Young's Prize.

1871 Graduated, B. A., Dalhousie.
1871 Won Gilchrist Scholarship.
1871-6 Student at Edinburgh and Leipzig.
1874 Took degree of M. A., Dalhousie.
1874 Took degree of B. Sc., London.
1876 Took degree of D. Sc., London.
1876-7 Lecturer on Physics at Dalhousie.
1877-9 Lecturer on Physics at Clifton College, Bristol, England.
1879-1901 Professor of Physics at Dalhousie.
1882 Charter F. R. S. C.
1882 Elected F. R. S. E.
1888-91 President of N. S. Institute of Science.
1891 Appointed Dean of newly formed Faculty of Pure and Applied Science, Dalhousie.
1899 Elected F. R. S.
1901-13 Professor of Natural Philosophy, Edinburgh.
1901 Given degree of LL. D., by Glasgow University.
1901 Given degree of LL. D., by Dalhousie University.
1913 Died, Edinburgh, May 21st.

In order to understand MacGregor's place and importance in the field of Science in this country, it is necessary to understand the position of Physics in his student days. To put it briefly: Natural Philosophy, as it was than called, was a text-book study; a laboratory for students was unknown; a student never touched an instrument, but only looked at such

from the respectable distance of his seat in the class-room—and then at only a meagre lot. There was an Atwood's machine (perhaps only a large diagram of it), a Hero's fountain, a model force pump, an air-pump, a feather-and-guinea-tube, Magdeburg hemispheres, a syphon, a barometer, a friction electric machine, and some spark apparatus, a gold-leaf electroscope, Zamboni pile, Volta cup, Leslie's cubes, a thermometer or two, a tuning-fork set, a balance, some hydrometers, and a dozen or two more such instruments—and the "cabinet" was complete. It is true that in various large universities there were professors working at research, but the laboratories were not visible to the undergraduate, and the idea of a laboratory course of instruction was absolutely foreign to the British mind. What didactic instruction might be given in the ordinary college was just as likely to be given by the professor of Classics or History, as that of Mathematics or Astronomy. The idea of a separate chair of Physics was not yet general.

When MacGregor went abroad to study Physics there were few places in the Old Country where he could get the kind of instruction he needed; not at Cambridge or Oxford, or Glasgow, or Dublin, though in all of these were able professors, and professors doing research work; but no place for students wanting to do so. However, at Edinburgh, Tait was allowing as a great privilege a few selected, promising students to go into his own private laboratory and help him with his researches, and, as they became capable, undertake part of them by themselves. Here MacGregor was initiated into the mysteries and delights of research, and began to "find himself," as an independent worker. The very fewness of Tait's students thus privileged was a great advantage to them, for they were very close to him and his work, and had the benefit of almost private tuition from that great leader in physical thought.

The German Universities, on the other hand, had developed regular schools of experimental teaching, and shrewdly invited students to come to them from all parts of the globe, and gave a special degree of Ph. D. to denote the termination of such a course of training. And thus began that 'set' toward German training, especially for men from this side of the Atlantic, that gave German Science and German scientists an unwarranted prestige, which Germany fostered until it became almost a cult and required a world-war for its undoing. MacGregor spent some time at Leipzig, and became a staunch believer in the experimental method of teaching science, and at the same time he became more and more convinced of the part science was to play in the progress of the future, and of its educational value as well. When he returned to his native land, it was as an apostle, a missionary, an enthusiastic devotee of his beloved Physics. From that time forward he worked and fought for the introduction of more science into the schools and colleges, with an ardor that no amount of opposition and conservatism and temporary failure could subdue; and it was a long uphill fight. He formed societies for its cultivation, addressed gatherings of teachers and schools and colleges, preached from the platform and through the Press. He was not merely an advocate of pure science; but as truly as we see it today he foresaw the meaning and value of applied science, and even organized out of voluntary local talent a still-born Institute along the lines of our modern Technological Institutes. The result of his efforts within the University is seen after twelve years of constant fight, when he had a Faculty of Pure and Applied Science set off and differentiated from the Faculty of Arts. He was made its first Dean.

With all his work as a teacher, and in spite of drawbacks that would have overwhelmed the average man and turned him into a mere hack, he never ceased his research work, but, on the contrary, was remarkably productive. No

one knew better than MacGregor that one has almost got to be an investigator in order to be a success as an inspiring teacher. How he managed to do the work he did, with practically nothing to do it with, has always remained a mystery to me. One wonders whether he would have accomplished much more, and how much, if he had had even the modest equipment of our physical laboratory of today. This fact is to be borne in mind, that his going to Edinburgh was the end of his career as an investigator; I do not know of a single paper of a research nature that he published after leaving Dalhousie. He became a reformer there, and administrative work absorbed his whole energy—and killed him, a warning of a barren portion of life and its ending which some of us might well take to heart.

I was one of his students in 1883-5, and I have been trying to recall what his so-called laboratory was like in that old building on the Parade; but though I can well recall the little lecture-room with its sloping floor, I cannot remember any laboratory. Of course, we students took only lectures; there was no such thing as a physical laboratory course. There was a course in practical chemistry which a few curious beings elected. I was one whose curiosity was aroused; we had practically no instruction, but were given a book of directions, and shown the aerie in the attic called the laboratory, and left to ourselves. We tried many combinations of the contents of bottles whose properties we were profoundly ignorant of, and got many strange and unexpected "reactions," and explosions; but how the buildings and our lives escaped is one of those results which a prophet would not have foretold. I do not know what chemistry we learned in the process, but we came away with a profound respect for Physics. When in 1887 I came back as tutor in Mathematics and Physics, MacGregor was in his new laboratory in what we now call the Old Building on Carleton Street. He

had deisgned it with loving care, and it was in my eyes palatial. There I did my first experimenting. As I recall the equipment he had then been able to gather together after about ten years of effort, it seems truly pitiful that such a man should have had such lack of tools. You could put it all in a good-sized wardrobe. Most of my work was done with a primitive lamp-and-scale galvanometer and Wheatstone's bridge and a Kohlrausch box of coils, with some spools of wire, sealing wax, etc. I spent months rewinding the galvanometer, resilvering its crippled mirror, and calibrating a stretched piece of German-silver wire to act as a potentiometer. Then another three months were given to finding the inversion point of a thermo-couple. I must not forget formidable efforts which I made to rehabilitate an Atwood's machine, whose warped supports, upright in name only, not in morals, and cogwheels stained with verdigris, pathetically called for rejuvenation. I got it so that it would go on Saints' days, when one called out all his patience and other virtues. This was MacGregor's laboratory, and yet out of it came all that series of researches, as complete a list of which as I could make in a hurry I have appended to this. He had to cut his pattern therefore to suit his cloth; and had to choose lines of research which could be done with a few chemicals, glass tubing, a balance, a thermometer, and pluck, determination and brains. Most of his work at this stage of his career was in connection with the new ionization theory, which he did much to advance from certain standpoints. He always complained to me of the way he felt hampered by his lack of a thorough grasp of mathematical physics; when I came back from Johns Hopkins he would frequently tell me how envious he was of the training I had received on that side of physics. But I think he did himself an injustice, though it is true he never trusted himself in that region of investigation or with that implement of attacking physical problems.

If MacGregor's laboratory and library equipment was so mean and inadequate, his mental equipment was of the very best. The characteristic I should put first is alertness; he saw your point before you made it; he saw every side of it; and almost instantaneously saw the correctness or the flaws in it. His reply came back like a flash, and almost beat you with its suddenness; he fairly overwhelmed you with his arguments drawn from many points of view. This mental alertness, acuteness and keenness was a part of his whole, quick, nervous make-up; he was built of springs, bodily and mentally. Such an alert and nervous temperament meant that he was not satisfied until a physical conception was absolutely clear to himself; he possessed no misty or foggy notions; he either knew a thing or did not know it. This characteristic was chiefly the secret of his excellence as a lecturer, when combined, as it was, with a good command of fluent expression. He was probably the best lecturer on Physics I ever heard; even the dullest boy thought he understood mechanics while at MacGregor's lecture (but he didn't); the presentation was absoltely logical, the illustration was apt, and there were no superfluous words to becloud it all. This type of mind is usually extremely impatient of dullness of intellect; but MacGregor possessed the necessary patience to make him a great teacher. I would add to this quality an abounding energy and a great power of concentration and great tenacity of purpose. Given these and his enthusiasm, it is easy to realize that the cause of science was assured of progress in this part of the world, no matter how much opposition and stubborn stupidity and prejudice it had to encounter. We, who have followed him owe him an unpayable debt for the easy path left for us to tread.

I would not place MacGregor so high as an original thinker. Keen and analytical as were his faculties, enabling him to see the bearing of all his knowledge, and, therefore, seemingly,

fitting him for extending the subject he was considering, he yet seems to have given vent to his critical faculties, rather than to striking out into unknown regions. This will be evident in his philosophical flights, as when he applied his analytical powers to dissect the fundamental bases of abstract dynamics. His forte was in making knowledge his own, and passing it on to others, rather than in making his own knowledge.

As would be expected from the qualities I have presented, MacGregor was a very expert experimental investigator; with his skill and ingenuity he made anything into apparatus, and made a little go a long way, and made it give him precision too. It would shame any one of us to be asked to reproduce any of his results with the apparatus he used. With it all he had a kindly, warm-hearted and cheery disposition, and a true Scottish loyalty to his friends that made him a delightful companion. His interests were wide, and he had a taste for good things in literature and in art, and he could tell a story or incident well. As a consequence an evening spent with him in the clouds of discussion and of nicotine were hours of real enjoyment. Dalhousie has been fortunate in many things, but in no respect more than in the quality of those members of her staff who dug her ramparts and set up her bulwarks in her early pioneer years, and of these the name of MacGregor is not the least.

"Forget not the MacGregor."—(Rob Roy).

Nova Scotian Inst., of Science,

May 13, 1918.

PUBLICATIONS

BY PROFESSOR JAMES GORDON MACGREGOR.

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Note on the Variation with Tension, of the Elastic Properties of Vulcanised India-Rubber. P. N. S. Inst. Sc., X, 1898-99.

On the Applicability of the Dissociation Theory to the Electrolysis of Aqueous Solutions containing two Electrolytes with a common Ion. P. R., VIII, March, 1899.

On Finding the Ionization of Complex Solutions of given Concentration and the Converse Problem. T. N. S. Inst. Sc., X, 67-78, 1899.

Matter, Energy, Force and Work. P. R., IX, 59-64, 1899.

The Utility of Knowledge-making as a means of Liberal Training. Address delivered at the opening of the fortieth session of Dalhousie College, Sept., 1899.

On a Diagram of Freezing-Point Depressions for Electrolytes. T. N. S. Inst. Sc., X, 211-234, 1900.

Ueber die Bestimmung der Dissociation von zusammengesetzten Lösungen von gegebener Konzentration und uber das umgekehrte Problem. Z. f. Physik. Chemie, XXIII, 529-539, 1900.

On the Depression of the Freezing-Point in Aqueous Solutions of Electrolytes. T. R. S. C., VI, (2), 3-19, 1900.

Research in the Scottish Universities. Inaugural lecture delivered at the University of Edinburgh, October 15, 1901.

MacGregor's Research Students.

A. Stanley Mackenzie	1885	Dalhousie University.
E. Mackay	1886	Dalhousie University.
A. M. Morrison (deceased)	1888	
H. M. Mackay	1888	McGill University.
W. H. Magee	1891	North Battleford.
C. L. Moore	1891	Dalhousie University.
T. C. MacKay	1893	Arizona University, Tucson
H. V. Bigelow	1894	Regina.
C. C. A. Lange	1895	
D. MacIntosh	1902	University of British Columbia.
D. S. McIntosh	1892	Dalhousie University.
C. M. Pasea (deceased)	1900	
E. H. Archibald	1897	Univ. of British Columbia.
J. Barnes	1899	Bryn Mawr College
T. C. Hebb	1900	University of British Columbia.
R. S. Boehner	1901	
L. L. Burgess	1905	

Dr. A. H. MacKay, Superintendent of Education for the Province, desired to put on record the highly valued work of MacGregor for the Public Schools, as Provincial Examiner in the scientific subjects of the Provincial High School Program, from 1893 to his departure for Edinburgh in 1901.

The President on bringing the meeting to a close said:

Your Honor, ladies and gentlemen:—

Dr. Mackenzie has given us exactly what I hoped he would, an appreciation of MacGregor the man and an account of the work of MacGregor the scientist. Dr. Mackenzie has stated clearly to us the nature of the contributions to science made by MacGregor, as well as shown us that he had pronounced views on the Philosophy of Science.

As regards the place of science in education in Nova Scotia, Professor MacGregor seems to have been a pioneer; and it is fitting that we should remember the work of all pioneers, especially that of him who was one of the brightest ornaments of the premier University of this Province.

I consider it a privilege to have been entitled to be in the chair this evening, a chair once occupied by MacGregor himself, and I regard it as an honor that it has fallen to me to take some part in a ceremony that has been designed for the special purpose of honoring him.

On motion of the PRESIDENT, seconded by HIS HONOR the LIEUTENANT GOVERNOR, a unanimous vote of thanks was passed to the donor of the portrait.

THIRD ORDINARY MEETING.

Physiological Lecture Room, Dalhousie Medical College, Halifax; 15th May, 1918.

THE PRESIDENT, DR. D. FRASER HARRIS, in the chair.

PROF. JOHN CAMERON, M. D., D. Sc., F. R. S. E., read a paper on "Two Remarkable Skulls from the New Hebrides," with lantern illustrations. (See Transactions, page 403).

The subject was discussed by the PRESIDENT, DR. E. MACKAY (who gave results of a chemical examination of a painted clay mask attached to one of the skulls), PROF. MCINTOSH, G. W. T. IRVING, COLONEL CROLL, M. D., DR. A. H. MACKAY, H. PIERS and DR. S. T. RITCHIE.

DR. A. H. MACKAY, read by title a paper on "Phenological Observations, Nova Scotia, for 1917." (See Transactions, page 395).

HARRY PIERS,

Recording Secretary.

THE

Proceedings and Transactions

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA.

VOLUME XIV

PART 1

SESSION OF 1914-1915

HALIFAX

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(Vol. xiv, Pt. i.)

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1914-1915.

The Distribution of the Active Deposit of Thorium in an Electric Field.—By G. H. Henderson, B.A., B. Sc., *Instructor in Physics*, Dalhousie University,* Halifax.

(Read November 9th, 1914.)

The problem of the distribution of the active deposits of radio-active substances in electric fields is an old one and was early investigated by Rutherford[1], Russ[2], Kennedy[3], and others. In much of this early work no attempt at precision was made and a considerable part of it was rendered of doubtful value by faulty experimental arrangements. The problem in the case of radium was more recently taken up by Wellisch and ronson[4] and by Wellisch[5] and in the case of actinium by Walmsley.[6]

It was felt that a similar investigation of the active deposit of thorium was timely and might throw further light on the mechanism producing the charged condition of the active deposit particles and on the conditions which affect their distribution in electric fields.

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* Contributions from the Science Laboratories of Dalhousie University—[Physics].

1. Rutherford, Phil. Mag., Feb. 1900, Jan. 1903.
2. Russ, Phil. Mag, June , 1908.
3. Kennedy, Phil. Mag., Nov. 1909.
4. Wellisch and Bronson, Am. Journ. Sci. XXXIII, May 1912.
5. Wellisch, Am. Journ. Sci. XXXVI., Oct. 1913.
6. Walmsley, Phil. Mag., Sept. 1913.

Practically all the testing vessels used in the above researches were cylindrical cases having an insulated rod in the centre. These vessels have the disadvantages of having an ununiform field and of presenting surfaces of unequal area to the active deposits. Therefore it was decided to try vessels having parallel plate electrodes. It is important that the testing vessel be so constructed that the active deposit particles or "rest atoms" would be deposited only on the electrodes and none on other parts of the vessel where they would remain unmeasured. To accomplish this several types of vessels were used, only two of which need be described. The construction of the first type is shown in Figs. 1 and 2. The electrodes were cut out of zinc as shown in Fig. 1. The flaps

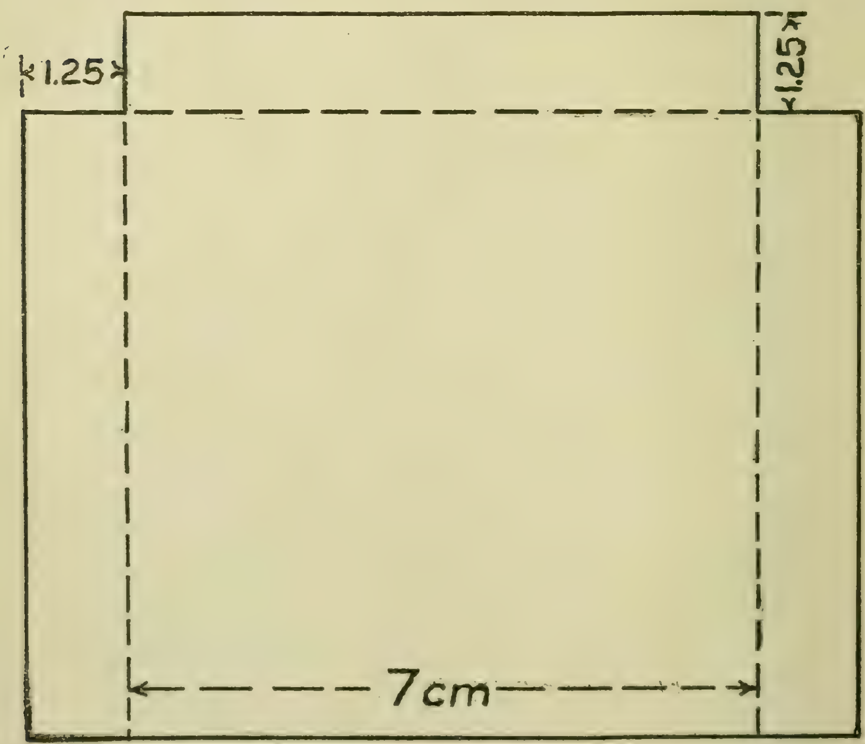


FIG. 1.

were folded over on the dotted lines forming a shallow box one end of which was missing. Two of these electrodes, their hollow sides facing one another, were slipped open ends downwards into a wooden case. The electrodes and case set up ready for an exposure are shown in cross section in Fig. 2. A A are the electrodes, B B is the case, C C are wooden pegs fixed in the sides of the case to separate the electrodes. The edges of these were .3 cm. apart making the main parts of the plates 2.8 cm. apart. D is the bottom on which the case rests. It projects up a short distance inside B. The top of this projection is slightly hollowed out, forming a shallow trough G on which lay the thorium hydroxide, which was used as source of the thorium emanation. The plates rest on the rim of the trough. E E are leads and F is the cover of the box. All the wooden parts of the apparatus were boiled in paraffin to secure good insulation. Owing to the long period of thorium B (10.6 hours) the experiments necessarily proceeded with some slowness. Exposures varying from 6 to 36 hours were made, about 24 hours being usual. The plates were then removed from the vessel and their activities measured. As the decay curve for thorium active deposit of long exposure is practically flat for the first half hour, no correction for decay during the time of measurement was needed, and even with exposures as short as 6 hours only a small correction was required. This has been applied when necessary. The activity of the plates was measured by an α ray electroscope, similar to that described by Rutherford.[1] The earthed case of the electroscope was surrounded by a second case of cardboard with glass windows, to protect the instrument from extraneous effects of air currents and temperature. A water filter was also used to eliminate the heating effect of the lamp. The gold leaf was charged to 200 volts and its rate of fall was observed through a tele-microscope. The time required to pass over a certain

1. Rutherford, Radio-Active Substances, p. 90, fig. 12.

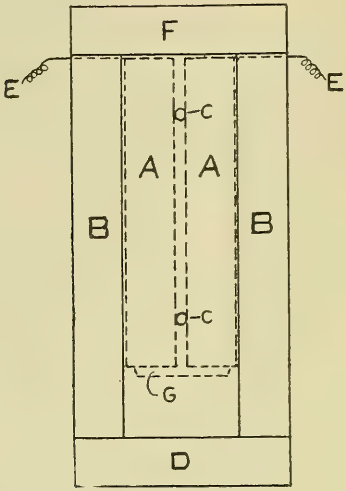


FIG. 2.

number of scale divisions was measured with a stop watch. This range of scale was kept the same for any given experiment. A correction for the natural leak of the instrument was always applied. This correction was usuall y a small fraction of th anode activity.

A typical set of measurements is given below:

Box 8 Plates 10 Voltage = 40.4. Dry air over H_2SO_4. Set up 2:15 P.M. Oct. 25, 1914.

Plates removed 9: 01 A.M., Oct. 26, 1914.

Plates.	Period.	Divisions.	Time.	Rate.	Cor. Rate.
10−	25.6″	60−50	9: 05 A.M.	.3906	.3880
10+	9′ 55.0″	60−50	9: 16 A.M.	.0168	.0142

Percentage cathode activity = 96.5.

The first line gives the conditions under which the exposure took place. The first column shows the electrode measured. The column marked "Period" gives the time taken by the gold leaf in moving over the scale divisions indicated in the next column. The column marked "Time" shows the time of conclusion of each measurement. The next column shows the rate of fall of the needle, while the last column shows this rate corrected for natural leak, and the decay when necessary. The corrected rate is a measure of the activity of the plate. The percentage cathode activity

$$=\frac{\text{Cathode activity} \times 100.}{\text{Cathode activity} + \text{anode activity.}}$$

The error in the values of the percentage cathode activity was mainly that made in measuring the anode activity. This error was seldom as much as 2 per cent. The readings were usually repeated several times and the mean taken.

An objection to these vessels might be raised, namely, that the plates are very close together at the edges, and that this distorted field was the determining part of the field. That this was not the case was shown as follows:

An exposure was taken as usual. The activities of the plates were measured as usual. Then the plates were covered with a zinc screen neatly covering the whole of the plates except a part in the flat portion of the plate where the screen was cut out, and which could expose a portion of either the top or bottom half of the plate. The size of this opening was 5.8 x 2.8 cm.

The activities of the plates were then measured with the lower and upper portions exposed. he results follow: Box 6. Plates 15. Volts 2.1. Laboratory air.

Whole Plates.

Activity on cathode = .604.*
" " anode = .294.
Percentage cathode activity = 67.3
Total activity on two plates = .89

Lower Portion Exposed.

Activity on cathode = .228.
" " anode = .114.
Percentage cathode activity = 66.7
Total activity = .33.

Upper Portion Exposed.

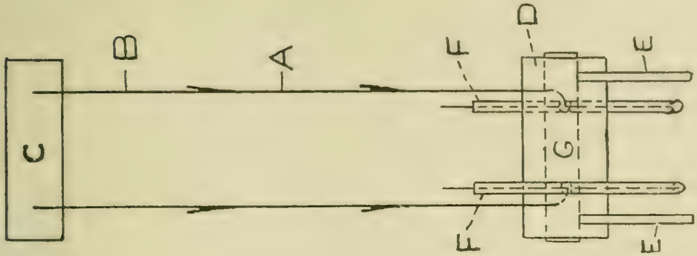
Activity on cathode = .157.
" " anode = .076.
Percentage cathode activity = 67.3.
Total activity = .23.

The size of the opening was about 22% of the total area of the plates including the sides. The relative total activities would show that the density of active deposit on the edges was less than that on the flat portion of the plates.

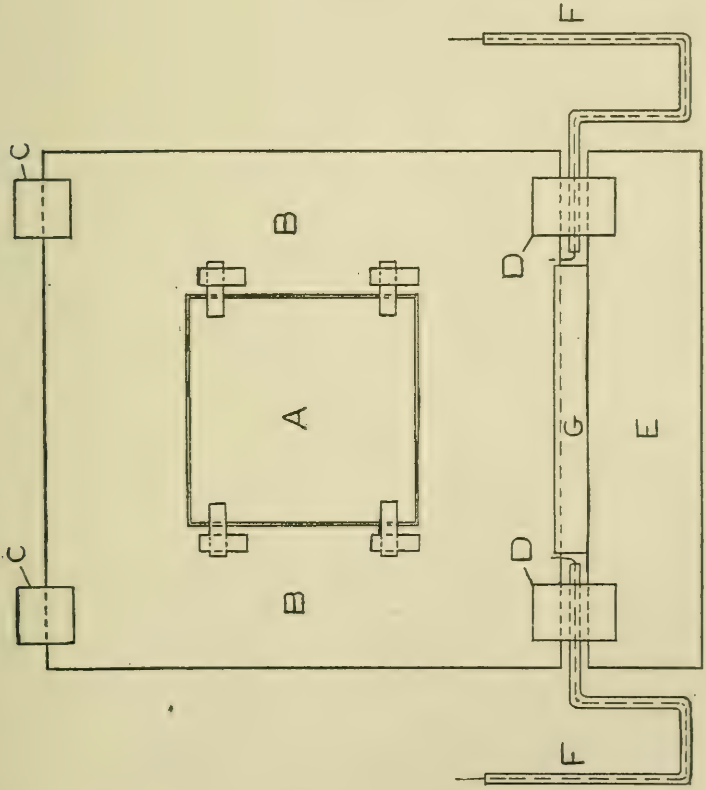
In general, fairly satisfactory results were obtained with this type of vessel. However, some discordant results were obtained which were hard to explain, but it was thought that the large amount of insulating material surrounding the electrodes might be the cause of these irregularities.

A second type of vessel was therefore constructed which avoided this difficulty as far as possible. End and side views of this vessel are shown in Fig. 3. The plates, which were of zinc, were made on the guard ring principle. The main plates, A, 5.8 cm. square, were slipped into place and held there by short lugs which engaged with clips on the back of the guard plate, B. The guard plates were 13 cm. square with an opening of 5.9 cm. square in the centre to receive the

*Arbitrary units.



End View—Fig. 3.



Side View—Fig. 3.

Fig. 3.

plates, A. The guard plates were kept 3.0 cm. apart by wooden blocks C and D at top, and bottom. The latter were supported on glass legs, E. The apparatus was set in a shallow glass dish and was covered by a rectangular glass jar. Control of the atmospheric conditions of the exposure was obtained by sealing the bell jar with a layer of liquid in the shallow glass dish. To secure dry air, concentrated sulphuric acid was the liquid used. In experiments on the effect of water vapor, water replaced the acid. For other gases a mercury seal was used to keep the desired vapor in the vessel. The thorium hydroxide was placed in a shallow wooden box G, under the plates and supported by the glass legs E. Connections with the plates were made by wires passing through glass tubes, F F, bent to pass under the bell jar through the liquid.

A number of advantages can be claimed for this type of vessel in studying the distribution of the active deposits.

The field is practically uniform over the plates A, any distortion of the field at the edges being eliminated by the guard plate.

No insulating material is near the electrodes.

Equal areas of electrodes are presented to the active deposit.

The activities of the two plates are measured under identically the same conditions, in the most simple manner, by a gold leaf electroscope.

Good control of gaseous conditions can be secured.

A series of observations was made with applied potentials varying from 6 to 12,000 volts. The highest voltage was obtained by the use of a Wimshurst machine run by an electric motor. The length of the spark gap was .35 cm. and the diameters of the knobs 3.0 cm. and 1.5 cm., giving an estimated voltage of 12,000. The air was dried by standing over concentrated sulphuric acid. The results obtained are shown in Table 1 and plotted in curve A, Fig. 4.

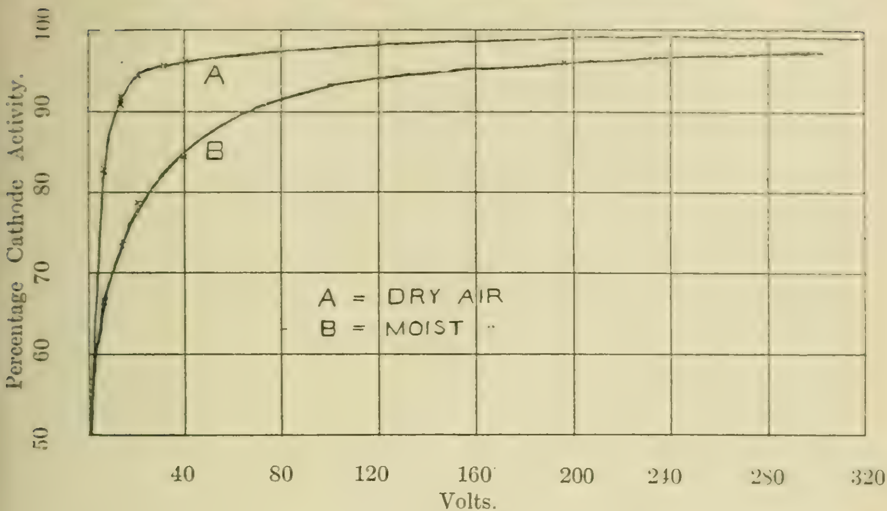


FIG. 4.

TABLE 1.

Volts.	Percentage cathode activity.
6.4	82.9
14.1	91.4
14.0	92.0
14.1	91.0
20.4	94.7
32.0	95.9
40.4	96.5
120.0	98.6
12,000.0	99.8

It will be seen that this curve has the general shape of the ionization saturation curve. The percentage cathode activity at 12,000 volts is the mean of three observations, in one of which the activity of the anode measured less than the natural leak. As this value differs from 100 by less than the observational error, there is no evidence to show that initially any fraction of the rest atoms is neutral. It must be understood that the use of the word initially, as in this instance,

refers only to a time after that infinitesimal fraction of a second during which recoil is operative. This curve differs in two respects from that found by Wellisch and Bronson for radium. (1) It reaches approximate saturation at much lower voltages. (2) There seems to be no evidence that any fraction of the rest atoms is initially unchanged. Experiments showed that the dimensions and form of the testing vessel and the concentration of the rest atoms are largely responsible for (1), and that approximate saturation in air is reached with about the same potential gradient for thorium as for radium.

Thus the evidence in the case of dry air would indicate that initially all the rest atoms of thorium are positively charged and that all the activity on the anode at low voltages is due to these rest atoms losing their charge by recombination with negative ions in the air.

It was found by Wellisch and Bronson that 10.4 per cent. of radium rest atoms were initially uncharged in dry air. Experiments were made to test whether this difference between radium and thorium was due to the type of vessel used.

The percentage cathode activity in the case of radium was measured with parallel plate vessels. The source of radium emanation used was a layer of radium chloride deposited on a sheet of aluminum. Preliminary measurements with the first type of vessel described, showed that this fraction was of the same order as that found by Wellisch and Bronson for cylindrical vessels. Later the experiment was repeated using the second type of vessel and a potential of about 12,000 volts supplied by the Wimshurst machine. The percentage cathode activity was found to be 5.2. This would make the total fraction unaffected by the electric field 10.4 per cent. in good agreement with the latest value (11.8) found by Wellisch[1].

1. Wellisch, Phil. Mag. Oct. 1914.

The distribution of the thorium active deposit was also measured in cylindrical vessels. The vessels were of the usual type. Air dried by passing over phosphorus pentoxide was passed over thorium hydroxide, and then through the testing vessel at a slow enough rate so that practically all the emanation would decay in the vessel. The activities of the rod and case, the rod being used as cathode, were measured by means of a Dolezalek electrometer. The activity of the rod was measured in a cylindrical vessel, free from active deposit, of the same dimensions as the anode case; while the latter was tested with a clean rod similar in dimensions to that used as cathode. The same general results were obtained as with the parallel plate vessels although the voltage necessary to bring over a given fraction of the rest atoms on to the cathode was higher owing to the difference in shape of the vessels. A similar rise of percentage cathode activity with voltage was found. With 280 volts (the highest used), the percentage cathode activity was 95.3.

From these experiments it will be seen that parallel plates and cylindrical vessels give concordant results.

To test if the variations between thorium and radium might be due to a surface effect of the electrodes, experiments were made to see if the surface conditions of the electrodes had any effect on the distribution of the rest atoms.

Experiments with copper and lead electrodes gave results similar to those obtained with zinc plates. The state of polish of the electrodes also had no effect on the distribution. These results are in accordance with those found for radium by Wellisch[1] and by Walmsley[2].

An interesting result found by Godlewski[3] might be referred to here. He found that on electrolyzing a solution of actinium, the active deposit was transported to the cathode, only when the cathode plate had previously been used as

1. Wellisch, Am. Journ. Sci. Oct. 13.
2. Walmsley Phil. Mag. Oct. 14.
3. Godlewski, Bull. Acad. Sci. de Cracovie, June 1913.

anode, and hence was electrolytically saturated with hydrogen. To test if a similar effect took place with thorium in air, experiments were made, using as cathodes plates previously used as anodes, and *vice versa*. No effect was detected within the limits of observational error.

It was found by Wellisch and Bronson that in the case of radium a much greater proportion of the rest atoms were uncharged in an atmosphere containing water vapor than in dry air. The effect of water vapor on the distribution of the rest atoms of thorium was accordingly tried. In order to obtain the maximum effect possible with water vapor experiments were made with air saturated with water vapor at room temperatures. This was accomplished by substituting water for the sulphuric acid of the previous experiments so that the plates stood over water. As the temperature of the laboratory varied from day to day the conditions under which the different results were obtained were not identical. The general effect however is seen in table 2, and is plotted in curve B, Fig. 4.

TABLE 2.

Volts.	Percentage cathode activity.
6.4	66.5
14.1	73.7
20.3	78.8
40.0	84.8
99.7	93.4
196.	96.0
313.	97.2

The effect of water vapor is evidently to greatly increase the rate of recombination. The question of its effect on the initial charged condition of the rest atoms will be referred to after the effects of ether vapor have been discussed.

It was found by Wellisch[1] that in an atmosphere of 8 cm. of ether vapor all the radium rest atoms were uncharged. The effect of adding ether vapor to the air was found to be very marked in the case of thorium. The apparatus was placed under a bell jar from which the air was then exhausted. Ether vapor in different quantities was added, air was then allowed to enter till atmospheric pressure was reached. The results obtained are shown in table 3 and graphically in fig. 5. The potential employed was 40 volts and old type vessels were used.

TABLE 3.

Ether added in cm. mercury.	Percentage cathode activity.
0	96.5
3.8	83.8
9.9	68.0
15.7	60.6
37.2[2]	54.5

The effect of different potentials in the case of ether vapor is shown in table 4. The ether vapor was saturated at room temperatures and the results therefore are not strictly comparable. The general effect however is seen. Old type vessels were used.

TABLE 4.

Volts.	Percentage cathode activity.
13.9	51.1
40.0	54.5
292.0	62.3

1. Wellisch, Phil. Mag, Oct. 1914.
2. Estimated, air saturated.

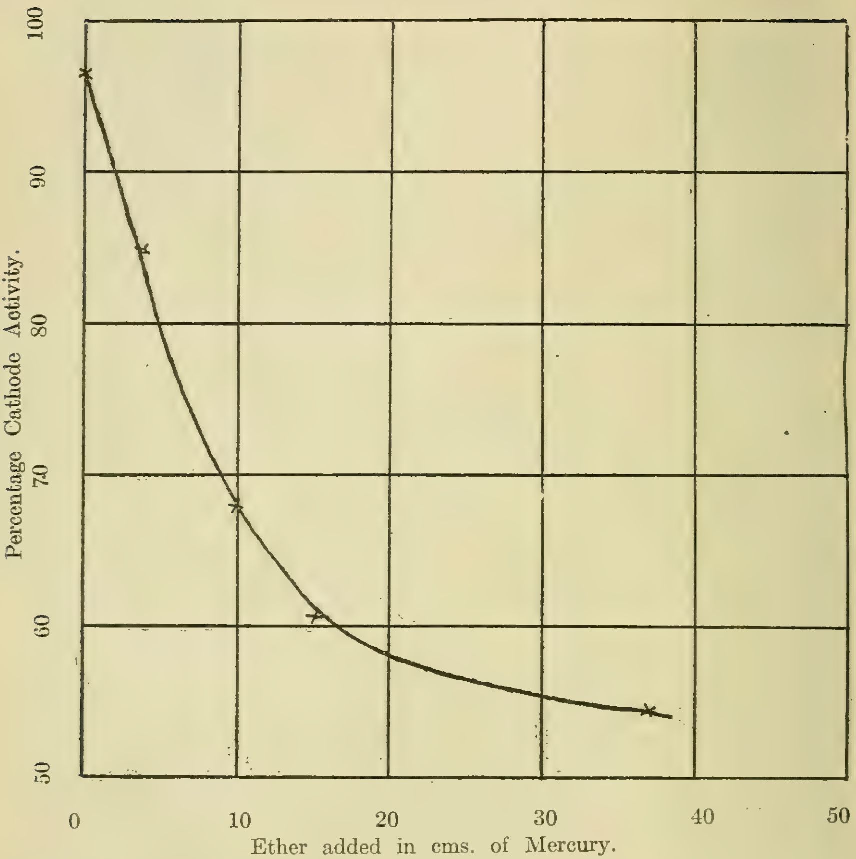


FIG. 5.

Two conclusions are suggested from these tables. 1st. With a given voltage the percentage cathode activity depends on the quantity of ether vapor present. 2nd. There is no evidence that with high potentials a value at all near 100 exists for the percentage cathode activity. This evidence points to the conclusion that part of the rest atoms are initially charged and part uncharged, and that the relative amounts of charged and uncharged rest atoms depend on the relative quantities of ether and air.

To further test this point, the following experiments were tried, the voltage in both cases being 313.

1st. The testing vessel was placed under a bell jar, the air exhausted and 10.2 cm. of ether vapor allowed to enter. Then air was admitted till atmospheric pressure was reached. The percentage cathode activity was 63.8.

2nd. The testing vessel was set up under a bell jar as before and the air exhausted to 0.7 cm. Then 10.2 cm. ether vapor were added and the exposure taken under a total pressure of 10.9 cm. The percentage cathode activity was 50.8.

A similar effect in the case of water vapor was sought. The bell jar containing a dish of water in addition to the testing vessel was exhausted to 1.6 cm. and an exposure taken using a potential of 312 volts. Owing to leakage the final pressure was 2.3 cm. The percentage cathode activity was 79.9. The exact proportions of water vapor and air in the bell jar were hard to determine but at least half the pressure was due to water vapor.

At such low pressures the percentage of the active deposit on the anode is increased due to recoil of the rest atoms. In order to test whether recoil could wholly account for the low value of the percentage cathode activity with water vapor, an exposure was taken using dry air at initial and final pressures of 1.35 and 1.55 cm. respectively. The percentage cathode activity was 94.6.

Thus we see that in an atmosphere of pure ether all the rest atoms are uncharged, which further strengthens the conclusions drawn from tables 3 and 4. The results with water vapor point towards similar conclusions, notwithstanding the experimental difficulty; the pressure of the water vapor being necessarily small, and there being a considerable fraction of air present.

Experiments tried in atmospheres of various other substances gave no evidence that in any pure atmosphere the

rest atoms were initially partly charged and partly uncharged. In this respect thorium seems to differ from radium. It was shown by Wellisch that, in hydrogen and in carbon dioxide, the rest atoms of the latter are partly charged and partly uncharged. The case of air is peculiar as it is a mixture. Further investigation along these lines is in progress.

Summary.

A new type of vessel for this kind of work has been developed and its advantages noted.

It has been shown that in dry air all the thorium rest atoms are initially positively charged.

In pure ether vapor all the thorium rest atoms are initially uncharged and in a mixture of ether vapor and air the charged condition of the rest atoms depends on the relative amounts of ether vapor and air present. A similar state of affairs appears to be true with water vapor.

In conclusion I wish to express my best thanks to Dr. Bronson, who suggested the work and without whose continued interest this work would not have been possible.

A Physical Measurement of X-Rays.—By Howard L. Bronson, Ph. D., *Professor of Physics* in Dalhousie University.

(Read 15 March 1915)

Introduction.

The use of Roentgen rays by the medical profession has increased very rapidly during the past few years, but, as yet, no method of measurement has been generally accepted. At present a large variety of instruments, methods, and units are used. For adding another method to the number already too large, the writer finds his justification in the fact that he not only employs a physical measurement of some accuracy, but also that is it not too complicated for practical use. All the physical principles used are old and have been used before.

The problem was suggested to the writer several years ago by Dr. G. P. Girdwood of Montreal, but a satisfactory galvanometer was not available at that time. The galvanometer needed for this work should be of the D'Arsonval type with a sensitiveness of at least 5×10^{-10} amperes per scale division, but should not be delicate mechanically. The resistance of the galvanometer is unimportant, but it should have as short a period as possible and at the same time be critically damped on open circuit. Dr. Edward Weston has recently developed an instrument which just meets these requirements. One of these he very kindly loaned for this work. The other things essential for satisfactorily carrying out this work were supplied by Dr. W. H. Eagar of Halifax, who was kind enough to place his office and most excellent X-Ray equipment at my disposal. In addition to this, experiments were carried on at Dalhousie University and at the Nova Scotia Technical College with the apparatus belonging to these institutions.

Roentgen rays are commonly used for two distinct purposes:

(1) For diagnostic work by means of fluoroscope and radiograph;

(2) For their therapeutic action.

In each case it is important to know both the quantity or intensity and the quality or hardness of the rays furnished by the tube. There are two *general* methods of measurement:

(1) The electric energy delivered to the bulb is measured and it is assumed that all or a constant fraction of this leaves the bulb as X-rays. A recent article by Dr. G. W. Holmes* shows that experience would seem to justify this assumption. This method does not distinguish directly between the quantity and quality of the rays, but the applied potential is taken as a measure of the hardness;

(2) The quantity and quality of the rays themselves may be directly measured; the quality by some form of penetrometer, which involves the comparison of the intensity of illumination of two surfaces; the quantity by the change produced in the color of some substance, such as barium platino-cyanide, in which case a color comparison is involved.

In a few cases the ionization produced in air has been used as a means of measuring the strength of the rays. Except for experimental difficulties, this should be the ideal method as practically all the evidence indicates that the various effects of Roentgen rays are directly related to their ionizing action. A simple direct reading instrument, making use of this principle, has been recently described by Dr. B. Szilard†. For some purposes this instrument should prove very useful, but for others the length of time necessary to get a reading would be objectionable. The instrument is calibrated to give directly the total number of ions formed in 1 c.c. of the air exposed to X-rays during the time of an exposure.

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*The American Journal of Roentgenology, May, 1914.

†Archives of the Roentgen Ray, June, 1914.

The writer also makes use of the ionizing action of X-rays, but employs quite a different method for measuring it. He is able in a few seconds to determine with considerable accuracy the intensity and hardness of the rays, as well as the time of exposure necessary to obtain radiographs of proper density, even under very unfavorable conditions.

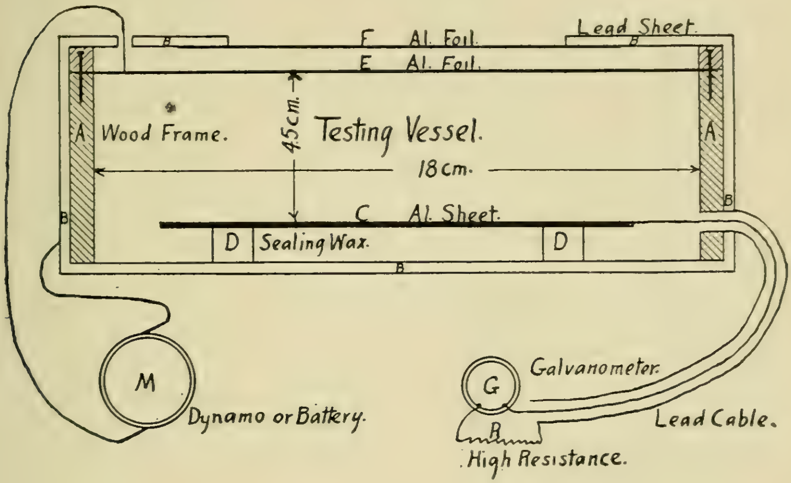


Fig. 1.

Apparatus.

Figure 1 shows a section of the testing vessel drawn approximately to scale and gives a diagram of connexions. The galvanometer was a Weston Model 89, having a tripod base, and was very easily adjusted by means of an attached spirit level. It was mounted on a window-stool, shelf or mantel according to circumstances, and its deflection was read by means of a lamp and scale. With the scale at a distance of one meter, it gave a deflection of 1mm. for a current of 3×10^{-10} amperes. The high resistance R. of about 10^6 ohms, was made by a pencil line on ground glass and was used merely to protect the galvanometer. The resistance of

the testing vessel was so high in comparison that R can be neglected in the calculations. M may be any fairly steady source of potential, high enough to produce practical saturation. It should be at least 100 volts and was about 200 in the present experiments. Sometimes it was obtained from storage cells and sometimes from a small 220 volt D. C. motor used as a dynamo and driven by a small A. C. motor.

One potential terminal was connected to the outside lead covering of the testing vessel and the other to the insulated aluminum foil E. The foil F was used to protect E from possible electrostatic action, and both were too thin to produce appreciable absorption of the X-rays. The aluminum plate C was very carefully insulated on sealing wax so that the galvanometer would be sure to measure the current due to the X-ray ionization between the plates E and C. The wire leading from C to the galvanometer was a small lead covered cable. The lead cover was connected through the high resistance R to one terminal of the galvanometer and to the lead case of the testing vessel, thus completing the circuit.

The X-ray tube was mounted at any desired distance directly above the opening F. The size of the bundle of rays entering the vessel was determined by placing on top of the vessel a lead sheet with suitable opening. Six tubes of various makes and construction were used and similar results were obtained with all. The smallest tube was about 13cm. in diameter and had a light platinum target, and the largest was about 18cm. in diameter and had a heavy tungsten target.

The different sources of power used included a large and a small induction coil with both Wehnelt and mechanical interrupters and a high tension transformer and commutator (Waite and Bartlett Mfg. Co.), giving an interrupterless current. The current through the tube was measured by a milliammeter, but the spark gap was the only means at

my disposal of estimating the potential on the tube. In the various experiments the currents used varied from 5 to 0.3 milliamperes and the spark gap from 8 to 18cm.

Experimental Methods and Results.

The present investigation may be divided into three distinct parts:

(1) To discover whether the action of Roentgen rays on a photographic plate is proportional to the ionization in the air near the plate, and thus to be able to determine the proper length of time for an exposure;

(2) To compare the action of the rays on a Sabouraud pastille with their ionizing action;

(3) To find an accurate method of comparing the hardness or penetrating power of the rays.

(1)

In order to test the first point the ionization current was measured with some object, for example several sheets of glass, aluminum or lead, covering the opening F of the testing vessel. Then a photographic plate, covered by the same object, was exposed to the action of the rays, produced under the same conditions as before. The X-ray plates used were either Ilford or Wellington, the developer was carefully prepared according to the maker's directions, and great pains was taken to always use the same quantity of fresh developer at the same temperature and to develop for the same length of time.

It was discovered by preliminary experiments that an exposure of 5 sec. gave a satisfactory negative, when the deflection of the galvanometer was 40mm. with a bundle of rays 100 sq. cm. in area. Thereafter the time of exposure of any plate was adjusted to be inversely proportional to the current through the galvanometer, that is, the product of the

time of exposure and the deflection of the galvanometer was always 200.

The procedure in a particular case where six sheets of lead foil, each .026mm. in thickness, was to be the subject radiographed, was as follows: The six sheets of foil were first placed over the opening F, the tube was started up and the galvanometer deflection was 30mm. The foil was then removed from F and a small photographic plate was placed at C. Upon this there were placed, side by side, three strips of lead containing respectively 4, 6 and 8 thicknessess of the above foil. The strips with 4 and 8 thicknesses each were used merely to have some contrast on the negative. The plate was then exposed for $\frac{200}{30}=7$ sec., with the tube working under as nearly as possible the same conditions as previously.

Over one hundred radiographs were taken as described. Various thicknesses of glass, aluminum and lead were used as the subjects for the radiographs and the rays in the different experiments differed widely in their characteristics, but the negatives showed practically the same photographic action on those portions covered by the materials under examination. Table I gives a record of six plates, all having lead foil for the subject of the radiograph, but taken with rays which were very different for the different plates. The first three were taken with a 17cm. tube having a tungsten target and using an interrupterless current and the last three with a 13cm. tube having a platinum target and operated by a small induction coil and a mechanical interrupter. The density of the negatives appeared to be alike within the limits of accuracy of the various measurements..

TABLE I.

Plate No.	Milliam-meter.	Spark Gap.	Lead.	Gal. Defl.	Exposure.
91	1.1	unknown	.104mm.	23	9 sec.
95	4.1	unknown	.208mm.	16	12.5 sec.
96	3.1	unknown	.208mm.	29	7 sec.
10	0.38	18cm	.104mm.	7	29 sec.
10	9.38	18cm	.156mm.	5.5	36 sec.
107	0.50	9cm	.104mm.	5	40 sec.

A comparison of the currents through the tube with the galvanometer deflections, in the cases of 95 and 96 and of 105 and 107, shows how unsafe it is to judge the intensity of the X-rays by the milliammeter alone. In both cases the current through the tube increased, but the galvanometer reading decreased, and the radiographs showed that the desired results were obtained by increasing the time of exposure, as was actually done. We must conclude then that the relative action of Roentgen rays on a photographic plate and in ionizing the air near the plate remains practically constant, however the rays themselves may be altered.

In order to compare the absorbing power of various parts of the body with various thicknesses of lead foil, radiographs of the knee, the thigh and the chest were taken with lead foil of varying thicknesses on the same plates. The results were rather unsatisfactory, because somewhat different results were obtained with rays of different hardness, and in practice it would be better to use aluminum sheet in place of lead foil for this purpose. However, the negatives showed about the same density for the following when the penetration was 8 or 9 Benoist:

Knee joint and	8 thicknesses	of foil	each .026mm.
Thigh bone and	10	"	"
Flesh of thigh and	8	"	"
Ribs and	10 or 12	"	'

By making such a comparison once for all, and using aluminum instead of lead, it would be possible in a few seconds by a single reading of the galvanometer, with proper thickness of aluminum over the testing vessel, to determine the time of exposure necessary to obtain a satisfactory radiograph of any part of the body. Of course, this would be of no practical value for powerful installations, where exposures are for only a second or two, but might be of great value where exposures for a considerable time have to be made.

(2)

In order to investigate the second point, a Sabouraud pastille was placed on the aluminum foil at F and exposed, sometimes to the direct action of the X-rays and sometimes with slight aluminum screening. During the time of exposure the deflection of the galvanometer was read at regular intervals The average of these readings multiplied by the time of exposure and by the galvanometer constant gave the charge that passed through the galvanometer, and this divided by the volume of air ionized and by the number representing the change in color of the pastille, as measured by Dr. Hampson's radiometer, should give a constant K, if the effect on the pastille is proportional to the ionization produced in the testing vessel. The last nine comparisons gave the following values for K: 2.4, 2.6, 2.7, 2.4, 2.5, 2.6, 2.4, 2.4, and 2.6, all multiplied by 10^8 Thus, we see that this method furnishes an accurate and quick method of testing the therapeutic action of any tube. In these experiments only the interrupterless current was used, but hard and soft tubes were tried with currents varying from 1 to 5 milliamperes.

(3)

Less attention was paid to the measurement of hardness than to the previous parts of the work, but a number of experiments were tried to see how the ionization current

through the testing vessel is changed by various thicknesses of lead or aluminum placed over the opening F, and in each case the hardness was measured by a Benoist penetrometer. Table II shows the nature of the results obtained in a single experiment.

TABLE II.

Hardness.	Sheets of Lead Foil, each .26mm thick.	Gal. Defl.	% of Max. Defl.
9 Benoist	0	178	100
	1	83	47
	2	51	29
	4	25	14
	6	15	8

Table III gives a summary of the results obtained with different tubes of various degrees of hardness. Columns 3 and 4 give the thickness of lead and aluminum necessary to reduce the ionization to half value. Column 5 gives the ratio of the ionization when there are two and when there is only one sheet of lead foil over F, and column 6 gives a similar ratio of the ionization for 4mm and 2mm of aluminum.

TABLE III.

Tube.	Hardness.	3	4	5	6
No. 1........	9 Benoist	.036mm	4.4mm	62%	73%
No. 2........	7 Benoist	....	3.5mm	.....	64%
No. 2........	6 Benoist	.023mm	....	45%	......
No. 2........	5 Benoist	.018mm	1.7mm	28%	43%
No. 4........	7 or 8 Benoist	.030mm	3.6mm	55%	68%

In practice it would be much easier and quicker to obtain the hardness of a tube from the data of column 5 or 6 than from 3 or 4. It is a well known fact, which is also clearly shown in Table III, that X-rays become less and

less easily absorbed the more lead they pass through. It is for this reason that the figures in columns 3 and 4 have been made to apply to rays which have already passed through .026mm of lead or 2.0mm of aluminum respectively.

Table III shows that the apparatus is well suited to make comparisons of the hardness of X-rays. It is only necessary to take two readings of the galvanometer, first with one sheet of foil and then with two sheets. The ratio of the readings may then be used as a measure of the hardness. By obtaining foil of the right thickness, it would be possible to arrange a simple scale which would correspond with any of the various penetrometers now in use.

Discussion of Results.

The experiments above described show how a single instrument may be very simply used to determine both the quantity and quality of the Roentgen rays from any tube, as well as the length of time of exposure needed to produce radiograms of proper density. In each case the ionizing action of the rays is made use of and the measurements are all made with a galvanometer, which avoids the uncertainty and difficulty of comparing the color or the equality of illumination of two surfaces.

The physical explanation would seem to be that the magnitude of the effect produced by the rays on the photographic plate, the pastille and in ionizing the air depends on the energy used up in each case, and that the relative amounts absorbed in the three processes remain practically constant for rays differing widely in their characteristics.

The nature of the apparatus makes it comparatively easy to calculate the number of ions produced per c.c. near the photographic plate during the time of exposure or near the pastille during the time of some definite change in color.

Let V = volume of testing vessel exposed to the ionizing action of the rays.

t = time of exposure in seconds of either plate or pastille.

N = total number of ions per c.c. produced in the testing vessel during time t.

e = charge on an ion—4.7×10^{-10} E. S. units.

k = galvanometer constant—3.0×10^{-10} amperes per mm. deflection.

d = deflection of galvanometer.

q = charge passing through the galvanometer in time t.

Then $q = NeV$ E. S. units (if there is no recombination).

also $q = kdt$ coulombs

and $NeV = (kdt)\ 3 \times 10^9$.

In the experiments with the photographic plates, as has been stated, t was so chosen that $dt = 200$, and V was $100 \times 4.5 = 450$c.c.

$$\therefore N = \frac{3 \times 10^{-10} \times 200 \times 3 \times 10^9}{450 \times 4.7 \times 10^{-10}} = 8.5 \times 10^8$$

Of course the value of N necessary to produce a satisfactory radiograph depends on the plate used and upon the method and time of development.

The average value of the constant $K = \frac{kdt}{V}$ found in the experiments with the Sabouraud pastille was 2.5×10^{-8}.

As above

$$N = \frac{kdt\ 3 \times 10^9}{Ve}$$

$$= \frac{2.5 \times 10^{-8} \times 3 \times 10^9}{4.7 \times 10^{-10}} = 1.6 \times 10^{11}.$$

This, then, gives the number of ions per c.c. formed in the air immediately surrounding the pastille during a change in tint corresponding to one number on Hampson's radiometer. Now the normal or epilation dose is determined by tint B, as it is called, and corresponds to a change equivalent to four numbers. Therefore, the number of ions per c.c.

produced in air surrounding the pastille during normal dose is 4N or about 6.4×10^{11}. In measuring this dose the pastille is ordinarily placed half way between the anticathode and the skin. Therefore the number of ions per c.c. produced near the surface of the skin during an epilation dose would be 1.6×10^{11}. This value is apparently very much smaller than that obtained by Dr. Szilard (loc. cit.), although there is some confusion in the part of his paper dealing with this calculation. A small part of this difference is due to the small value, 3.4×10^{-10} which he used for e, but the chief difference is due to the nature of the testing vessels used in the two experiments.

The vessel used by Dr. Szilard had a volume of 1 c.c. and was lined with lead. In a vessel of this kind the ionization due to secondary rays would be very large. Some of the secondary rays are very easily absorbed, but produce an intense ionization for a millimeter or two in air, so that their relative effect is especially great in a small vessel. The effect is also much greater with a lead than an aluminum vessel. Even in the large vessel used in the present investigation, the ionization was doubled by covering the plate C with lead foil. In the smaller vessel the ionization caused by the secondary rays might be several times as large as that due to the X-rays themselves. That the effect of the secondary rays from the aluminum plate C was small, was shown by covering C with a sheet of wet tissue paper, which reduced the ionization current less than 10%.

There is a still greater objection to using lead instead of aluminum for the interior of the testing vessel; namely the fact that the relative amount of secondary ionization depends on the hardness of the rays. The extra ionization in the testing vessel also requires the use of a higher voltage in order to prevent recombination.

Summary.

1. It has been shown that the action of Roentgen rays on a photographic plate and on a Sabouraud pastille is

proportional to the ionization produced in the air immediately surrounding them.

2. A simple apparatus, making use of this principle, has been devised for measuring the intensity and hardness of the rays.

3. It has also been shown that this same apparatus can be easily used to determine the length of time of exposure needed to produce radiographs of suitable density.

In conclusion, I desire to express my indebtedness to Dr. Edward Weston for his kindness in fitting up and loaning me a galvanometer suitable for this work; to Principal Sexton and Professor Ayars of the Nova Scotia Technical College for the use of their X-ray apparatus, and especially to Dr. W. H. Eagar for his many helpful suggestions and for the use of his office and equipment.

Dalhousie University, Halifax, N. S.
March 15, 1915.

An Investigation of the "Chromate Method" for separating the Alkaline Earths.*—By Hubert Bradford Vickery, Dalhousie University, Halifax.

(Read 11 January 1915)

This investigation was undertaken with the twofold object of discovering the degree of sensitiveness of which the ordinary "chromate method" for the separation of the alkaline earths is capable, and also under what conditions this sensitiveness may be increased. Incidentally a considerable improvement was made in the procedure.

Throughout the experimental work the idea was kept constantly in mind to have the conditions of working as nearly as possible those which obtain in the manipulation of the average student of qualitative analysis, and where these have been changed, to make them very easily attainable, so that the final quantitative results might fairly represent the degree of accuracy obtainable in ordinary work.

While several methods exist for the separation of the alkaline earths which are extremely delicate, † they depend largely upon the use of alcohol and ether to decrease the solubility of the various precipitates, and hence are scarcely suitable for class use. The chromate method, on the contrary, uses water solutions alone and obviates the necessity for inconveniently long waits for complete precipitations, thus greatly decreasing the time required for a single analysis and making this method eminently suitable for use in class. The procedure ordinarily followed ‡ consisted in precipitating the carbonate in strongly alkaline solution, magnesium being held in solution by means of ammonium chloride. The

* Contributions from the Science Laboratories of Dalhousie University (Chemistry).

† J. Am. Chem. Soc., **30,** 611. (1903).

‡ G. S. Newth: Manual of Chemical Analysis, p. 35.

carbonates were then dissolved in the least possible quantity of acetic acid, the solution diluted, barium removed as chromate, and ammonium sulphate added to the filtrate. This was supposed to throw down the insoluble strontium sulphate, but retain the calcium by its solvent action upon calcium sulphate.

It was at this point that difficulty was usually encountered as the calcium almost invariably came down in some quantity, especially if present in large amounts, rendering a complete separation impossible and obscuring the confirmatory flame tests. However, sufficient calcium was retained to give the confirmatory oxalate test, and by again bringing the precipitate into solution and treating with a solution of calcium sulphate, the strontium was confirmed even in the presence of a large amount of calcium. This method, resulting as it does in only an approximate separation, is unsatisfactory, and attempts were made to improve it.

Solutions of barium, strontium and calcium as chlorides were made up and carefully standardized gravimetrically, the first two by precipitating a known volume with silver nitrate, and the last with ammonium oxalate. Appropriate volumes of these solutions were run from burettes into flasks and made up so that each solution should contain a milligram of the metal per cubic centimeter. These standard solutions were used for the analysis.

The first step was to investigate quantitatively each precipitation occuring throughout the procedure and record its delicacy under the conditions normally occuring in the course of an analysis. The method followed was to run various quantities of the standard solutions into a series of beakers, dilute them with hot water, and add the cold reagents in the order given. This resulted in the precipitation taking place at a temperature of 65°-70°. By watching the row of beakers it was easy to compare the amounts of precipitate occurring and to find that one which yielded no precipitate,

thus fixing a lower limit to the sensitiveness of the particular precipitation, and ensuring uniform conditions.

The reagents used were:—Ammonia sp. gr. .90 (equivalent to three times the volume of sp. gr. .96).

Ammonium Chloride	10%
Ammonium Carbonate	25%
Potassium Chromate	5%
Ammonium Sulphate	10%
Ammonium Oxalate	5%
Acetic Acid	50%

BARIUM CARBONATE

The precipitating reagents were 3cc NH_4OH, 10cc NH_4Cl, 10cc $(NH_4)_2CO_3$. The total volume of the solution was 100cc.

0.5 mg. of barium gave no precipitate.
1.0 mg. gave no precipitate.
2.0 mg. gave no precipitate.
3.00 mg. gave very slight deposit on lines of rubbing with glass rod.
5.0 mg. gave slight deposit.
7.0 mg. gave very slight precipitate.
10.0 mg. gave feathery crystalline precipitate in few moments.
25.0 mg. gave feathery precipitate almost at once.

STRONTIUM CARBONATE

Conditions same as above.

0.5 mg. of stronium gave no precipitate.
1.0 mg. gave very slight precipitate in 5 minutes.
2.0 mg. gave slight precipitate in four minutes.
4.0 mg. gave decided precipitate in few monents.
10.0 mg. gave fairly heavy precipitate, but not coming down instantly.
25.0 mg. gave heavy precipitate at once.

CALCIUM CARBONATE

Conditions same as above.

0.3 mg. of calcium gave no precipitate.
0.5 mg. gave no precipitate.
0.6 mg. gave very slight precipitate.
0.8 mg. gave slight precipitate.
1.0 mg. gave slight precipitate in 4 minutes.
5.0 mg. gave precipitate almost at once.
10.0 mg. gave heavy crystalline precipitate at once.

It was found that a temperature much in excess of 70° caused an interaction of the carbonate with the ammonium chloride, giving an evolution of carbon dioxide and resulting in the solution of the precipitate or complete failure to form a precipitate.

In each case completeness of precipitation of a solution containing 25 mg. of the metal was tested by filtering after ten minutes and allowing to stand over night. Only in the case of barium did any deposit form and even in this case it was in very small quantity. The precipitates were examined microscopically, but it was found that although the crystals when falling from very dilute solutions were quite easily differentiated, from more concentrated solutions they were almost indistinguishable, especially since calcium, and to a lesser extent barium, show a tendency to come down as gelatinous masses from cool solutions.

BARIUM CHROMATE

Precipitating reagent, 3cc K_2CrO_4. Total volume of solution, 100cc.

In neutral solution, even one tenth of a milligram of barium gave a cloudiness in five minutes, but in a solution containing 1-2cc acetic acid 2 mg. failed to give a precipitate, while 2.5 mg. gave a slight one on standing a few

minutes. 5 mg. gave a precipitate almost at once. Boiling temperature was used.

STRONTIUM CHROMATE

Precipitating reagent, 15cc K_2CrO_4. Total volume of solution, 200cc.

In neutral solution 200 mg. of strontium gave a very slight deposit in beaker in ten minutes. 400 mg. gave a heavy precipitate in a few moments. In solution containing acetic acid, 500 mg. failed to give a precipitate over night.

CALCIUM CHROMATE

Conditions same as in precipation of strontium chromate.

In neutral solution 500 mg. of calcium gave a barely perceptible precipitate in fifteen minutes, while in acid solution none formed at all.

The barium chromate when suddenly thrown down is very fine and scarcely crystalline, but boiling for a few minutes causes it to crystallize. Under the conditions of ordinary work there is little risk of obtaining a precipitate of strontium chromate, while the barium is almost completely removed.

STRONTIUM SULPHATE

Precipitating reagent, 10cc $(NH_4)_2SO_4$.

2 mg. failed to give a precipitate on boiling while 2.5 mg. gave a scarcely perceptible one. 4 mg. gave very slight precipitate on standing. 10mg. gave a precipitate in a few moments. The experiments were repeated with both neutral and acetic acid solutions, with practically identical results.

CALCIUM SULPHATE

Precipitating reagents, 2cc acetic acid, 10cc $(NH_4)_2SO_4$. Temperature, 70°C.

200 mg. gave heavy feathery precipitate at once.

100 mg. gave small precipitate in one minute, which rapidly increased in size.

90 mg. gave small precipitate on standing an hour.
75 mg. gave no precipitate on standing.

Thus, under the conditions of ordinary work, calcium when present in excess of 90 mg. is precipitated along with the strontium. 200 mg. of calcium, and 40cc of $(NH_4)_2SO_4$ gave a heavy precipitate on warming, but no solvent action was noticeable on boiling; 40cc more were added and boiled and a slight solvent action took place. On adding 40cc of ammonium chloride to this solution it was observed that the greater part of the precipitate went into solution on boiling for a few moments. As this action appeared important, it was determined to investigate it further.

To try the effect of the addition of ammonium chloride before precipitating the sulphate, two solutions of 400 mg. of calcium each were prepared. To No. 1 were added 40cc NH_4Cl and to each 1cc of acetic acid. Both were brought to 70° and 10cc $(NH_4)_2SO_4$ added. The effect of the ammonium chloride was very noticeable, for in five minutes only a very few crystals had appeared in No. 1, and very little deposit had formed on the bottom of the beaker, while in the second beaker the precipitation had been heavy and was nearly complete. Other experiments were tried, and it was found that 80cc of ammonium chloride solution were sufficient to prevent completely the precipitation of 200 mg. of calcium, while 50cc failed to do so, as a slight deposit formed on boiling. 160cc were sufficient to hold up 400 mg. of calcium, showing that there should be 80cc of ammonium chloride present for each 200 mg. of calcium. It was found that the total volume should be not less than 150cc as a smaller volume rendered the precipitation of the calcium more likely. The effect of the ammonium chloride upon the strontium was investigated, and it was found that in the presence of a large excess, 4 mg. gave a precipitate on boiling, while 3mg. gave a very slight turbidity. Thus the effect is scarcely appreciable. The amount

of ammonium chloride is perhaps somewhat excessive, but it was found that when much smaller quantities were used, the calcium was liable to fall when the solution was boiled or digested on the water-bath. It is quite easy to tell from the character of the precipitate at this point if the calcium is precipitating. The strontium precipitate is very fine grained and falls immediately. The calcium sulphate precipitate, especially if ammonium chloride is present, is feathery, crystalline and forms slowly. It usually forms first at the surface, and is particularly liable to come down on boiling.

CALCIUM OXALATE

0.1 mg. of calcium gave a perceptible precipitate on standing for a few minutes. The effect of ammonium chloride in considerable quantities seemed to be to make the precipitation rather slower, but 0.1 mg. could still be easily detected.

SENSITIVENESS OF METHOD

The next step in the investigation was to carry out a series of analyses under normal conditions, using large excess of two of the metals and varying small quantities of the third until it could no longer be detected by the methods used. In this way the limit of detectability for each metal in the presence of excess of the others was found *when the complete analysis is carried through.*

A solution containing 4 mg. of barium and 200 mg. each of calcium and strontium was made up. The carbonates were precipitated and allowed to digest at 70° for 15 minutes, and then filtered and dissolved as usual. A slight precipitate formed in 5 minutes after adding 5cc of the chromate and on boiling and filtering a distinct yellow deposit was left on the filter after washing the potassium chromate out. A similar solution, but containing only 3 mg. of barium

as chloride, failed to form a precipitate in 15 minutes, or to leave a deposit on the filter. Hence the limit of detection of barium using the ordinary procedure is 4 mg. when excess of the others is present.

A solution containing 15 mg. of strontium and 200 mg. each of calcium and barium was treated by the ordinary procedure and the barium removed. Insufficient ammonium chloride was added and a considerable precipitate formed with the ammonium sulphate. This was boiled with ammonium carbonate and dissolved in acetic acid and calcium sulphate added. A very fine precipitate formed in the course of a few hours. A similar solution was taken and sufficient ammonium chloride (i.e. 80cc) was added, after removing the barium, to hold up the calcium. A very fine granular precipitate was obtained with ammonium sulphate in a few minutes, and no trace of the typical calcium crystals. Its identity was easily established. A solution with 13 mg. of strontium failed to give a precipitate, hence the limit of detectability of strontium is 15 mg. when an excess of barium and calcium is present.

A solution containing 1 mg. of calcium, 200 mg. of barium and 500 mg. of strontium was treated as before, and the barium and strontium removed as chromate and sulphate respectively. A fine white precipitate appeared in a few moments on making alkaline and adding ammonium oxalate. A solution containing 0.5 mg. gave no precipitate on boiling 15 minutes, but gave a very fine deposit on standing over night. Hence, the limit of detectability of calcium is 1 mg. or somewhat under, when excess of barium and strontium are present.

PROPOSED PROCEDURE

The results of the investigation can best be summarized by giving a procedure with notes for the separation of the alkaline earths by the improved chromate process.

PROCEDURE I. *Precipitation of group (after ridding of sulphur).*

To solution after removal of iron and zinc group, (60cc), add 10cc NH_4OH, 20cc NH_4Cl and 20cc $(NH_4)_2CO_3$ at a temperature of 70°, and let stand several minutes. Filter and wash with little cold water.

Notes—1. At temperature much above 70° the carbonates react with the ammonium chloride forming the soluble chloride with evolution of carbon dioxide.

2. At temperature much lower calcium comes down as a gelatinous mass and barium also has this tendency. Warming on the water bath will cause them to crystallize.

3. Precipitation of strontium and calcium is complete in 10 minutes and of barium very nearly so.

PROCEDURE II. *Precipitation of Barium.*

Pour a 5cc portion of acetic acid through the filter a few drops at a time, and pour through repeatedly until it runs through clear. Then wash thoroughly with hot water. Make up to 80cc and heat to boiling. Add 5cc of K_2CrO_4 solution a few drops at a time with constant stirring and boil a few moments. Filter and wash with cold water. (Yellow precipitate shows presence of barium)

Notes—1. The 5cc of 50% acid should be diluted somewhat and used hot.

2. 500 mg. of calcium and strontium fail to precipitate under these conditions while 4 mg. of barium give a distinct test.

3. The filtrate should be yellow rather than red, but should be tested with another drop of chromate.

PROCEDURE III. *Confirmatory test for Barium.*

Pour a little hot HCl through the filter repeatedly and evaporate almost to dryness. Test in flame on platinum wire. Green color confirms barium.

PROCEDURE IV. *Precipitation of Strontium*

Evaporate to about 80cc and add 80cc of NH_4Cl for every 200 mg. of barium present; in no case less than 80cc. Add 10-15cc $(NH_4)_2SO_4$ solution. *Fine granular white precipitate* indicates strontium. Heat to boiling and let digest a few moments. Filter and wash with hot water.

Notes—1. Calcium, if present to the extent of 100 mg., will precipitate at this point unless held in solution by a large quantity of NH_4Cl. If a feathery precipitate in quite large crystals appears on heating, it is probably calcium.

2. Ammonium chloride inhibits the precipitate of strontium to only a very slight extent.

3. 15 mg. of strontium can be easily detected in the presence of large amounts of barium.

3. The confirmatory test should always be tried.

PROCEDURE V. *Confirmatory test for Strontium.*

Boil the precipitated sulphate with ammonium carbonate and neutralize with acetic acid. Concentrate to 10-20cc and filter if necessary. Add saturated solution of $CaSO_4$ and boil. Fine white precipitate confirms strontium.

Note—1. The strontium sulphate is converted to carbonate by the ammonium carbonate and brought into solution by the acid. The calcium is likewise converted but calcium acetate cannot give a precipitate with calcium sulphate, while the less soluble strontium sulphate separates at once on heating.

PROCEDURE VI. *Precipitation of Calcium.*

To the hot filtrate add NH_4OH to strongly alkaline reaction and then 10cc more. Add 20cc hot $(NH_4)_2C_2O_4$ solution and stir. White precipitate indicates barium.

Note—1. 1 mg. of calcium can be easily detected in the presence of 400 mg. of barium and strontium.

Summary

1. Each precipitation occurring in the chromate process for the separation of the alkaline earths has been quantitatively investigated.

2. The chromate process has been found not to effect an exact separation of the three metals.

3. An improvement has been suggested by which the separation is practically complete, and a procedure formulated.

4. The limit of detectability for each metal by this procedure has been determined.

Notes on an Abnormal Wave Occurrence on the Northern Cape Breton Coast.—By D. S. McIntosh, B. A., M. Sc., Professor of Geology, Dalhousie University, Halifax, N. S.

(Read 12 April 1915)

The occurrence which formed the basis of this paper, while relatively of little importance, is thought by the writer to be of sufficient interest to be recorded in the Transactions of the Institute.

In a small indentation on the northern coast line of Cape Breton Island between Cape St. Lawrence and Bay St. Lawrence, is situated the little settlement of Meat Cove. It has no harbor, and the boats of the fishermen, after each trip, are hauled up on the beach beyond reach of the waves.

From correspondence with Mr. Joseph O'Brien, of Dingwall, Aspy Bay, supplemented by personal observation, Mr. A. H. McIntosh, of Pleasant Bay, furnished the writer with the following description of the wave phenomenon:

The monthly bulletin issued by the Department of Marine and Fisheries, Ottawa, gives the total catch of fish for Canada, also the kinds of fish, quantities and values. It also aims at giving such information as weather conditions during the month, loss of life, boats and gear among the fishermen.

In the copy for June 1914, we find this entry: "Nine boats were lost at Meat Cove, Victoria County." Had the facts connected with this loss been given they would have interested the readers of the publication. The following statement is given as what occurred. "On the evening of the night on which the boats were lost, the fishermen had

hauled them up on the beach to a place where they were considered to be in safety. A light wind began to draw from the land, and all the usual signs in which fishermen believe promised a fine night. Judge of the surprise of those men when on coming to the beach in the very early morning not only were their boats gone, but they were not even in sight on the sea. Eventually, one or two were found along the shore, but others were found only after some days had elapsed, picked up at great distances from the starting-place. The marks on the beach showed plainly that the tide had come up very much higher than usual, and while at this place, it seemed to have been the highest, it was also noted as an unusually high tide at Pleasant Bay on the west, and Bay St. Lawrence and Aspy Bay to the eastward. One man near Bay St. Lawrence, at about eleven o'clock, saw it come in the form of two large seas succeeding each other, and rushing on shore. A fishing schooner lying some two miles off shore also reports several heavy seas striking the vessel about the hour mentioned; otherwise the night was calm. Some six years before, this same vicinity was visited by something of the same nature, but as it came in the day, it occasioned no loss."

The above account shows plainly that the disturbance was abnormal. That it falls outside the category of tide phenomena is evident. It occurred on a calm night and consisted of a succession of high waves which continued for a brief period of time. Tidal waves of the nature of a bore or as the result of conflicting currents are in the highest degree improbable as an explanation. In searching about for a probable cause, one recalls some well-known and strikingly disastrous effects of great abnormal sea-waves.

In 1755, Lisbon was laid in ruins by an earthquake which had its origin about 50 miles off the coast. About half an hour after the shock, a succession of high waves, one of which had a height of 60 feet, reached the city and added

to the destruction wrought by the earthquake. The waves were felt with diminishing effects at great distances, even north as far as Norway, south beyond the Madeira Islands, and west in the West Indies.

Japan was visited by a severe earthquake in 1854. Its focus was also evidently off the coast, for about a half hour after the shock, a series of waves thirty feet high struck the shore and destroyed the town of Simoda. From this spot the waves radiated with diminishing force, travelling the whole breadth of the Pacific to California.

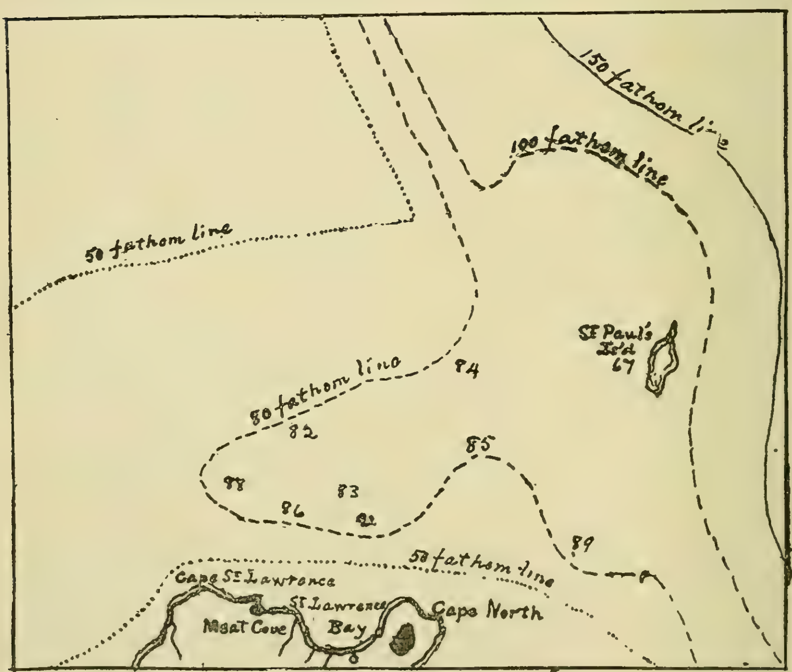
The Coast of Peru was devastated by a great earthquake in 1868. The seat of disturbance was likewise off shore, for in less than half an hour a succession of waves fifty or sixty feet high rushed in and increased the work of destruction of the earth-waves. These waves were felt thousands of miles from the seat of origin, even as far as the coast of Japan, 10,000 miles away.

Many other cases of such waves have been observed and recorded by tidal gauges, such as that of 1877 at Iquique in Northern Chile, and that of 1885 around Krakatoa. The great disturbance of 1896 in the North Pacific will be recalled by many, where 175 miles of the Japan Coast were laid waste. A great amount of shipping was destroyed and 27,000 people lost their lives.

These waves are caused by a dislocation of the earth's crust beneath the sea. The break occurs most often where the water deepens rapidly, as in the case of the western coast of South America where a few miles off shore the water suddenly plunges from the edge of the continental shelf to the ocean abyss. Similarly, off the Japan Islands the descent from the land platform to the Tuscorora Deep is very abrupt. The evidence is abundant and strong that such a condition of land and sea makes a line of weakness in the earth's crust and here may, and does, occur faulting or slipping. As

observed from the shore, the sea, during a disturbance of this kind withdraws from the land, and then returns with great speed and height causing great destruction.

In the opinion of the writer, the cause of the disturbance in Northern Cape Breton was a slipping of the rock, either solid or unconsolidated material, off the coast of Meat Cove. The accompanying map shows the locality where the disturbance was greatest, and the adjoining areas.



It is seen that a short distance east of St. Paul's Island the water deepens very rapidly. Here is the western margin of the submerged channel of the old St. Lawrence river. The 100-fathom line approaches to within about a mile of the island. Here, where there is a declivity of steep grade, a slipping or break in the bottom might be looked for. No

record of the disturbance, however, is obtained from St. Paul's Island, and, moreover, the description of the phenomenon localizes it rather between the island and the adjoining Cape Breton coast. The *isobathic* lines constructed from the chart show the 50-fathom line about two miles off Meat Cove, with the 80-fathom line about an equal distance beyond that. Here, in all probability, was the seat of the disturbance. A deepening of 80 fathoms in about 4 miles gives a gradient of about 1 foot in 44 feet or a 2¼% grade. The depths as given on the chart within the area bounded by the 80-fathom line suggest an uneven bottom where may be found steep slopes. Doubtless a large thickness of unconsolidated material has accumulated on the sea bottom. A sliding of this along the slope or a break in the solid rock would give the necessary impetus to the water to produce the waves.

When weather indications point to a calm night, boats are hauled up by the fishermen just beyond the range of high tides. The average difference between high and low water at Meat Cove, we may take as about four feet. To sweep the boats away would require an additional height of water of, say, three or four feet. Waves, therefore, of six or eight feet must have rolled in upon the shore to accomplish the work recorded. If the ordinary proportion between height and length of wave were preserved, the length of these waves must have been sixty or eighty feet. A slip of a belt of rock a hundred or so feet in width on the sea bottom near the 80-fathom line, or within the area bounded by this line would cause a gravitational movement to the water from the landward direction, followed by a return of the water, in the form of a succession of high waves. These waves would diminish in force as they radiated from the place of origin, as was observed to the eastward and westward of Meat Cove. Did the dislocation produce a rise in the sea

flow, the water would be lifted and the accompanying phenomena would be of the same nature as those that would occur in the case of the downward movement.

From the occurrence of a similar wave disturbance at Bay St. Lawrence some years before, as reported, it would be inferred that the surface of the sea bottom is unstable off the coast of Northern Cape Breton, and that such disturbances may recur until the area has arrived at a state of stability.

Accidental Electrical Stimulation of the Human Retina in Situ. — By D. Fraser Harris, M. D., D. Sc., F. R. S. E., Professor of Physiology in Dalhousie University, Halifax.

(Read 10 May 1915)

In the summer of 1912 I had a lower left molar tooth filled with a temporary stopping consisting of an amalgam of at least three metals, silver, mercury, and tin. Within half an hour of having this inserted I noticed that each time I clenched the jaws at all forcibly, there appeared a bright flash of light in the left eye; all through the rest of the day flashes of light, getting fainter and fainter, kept recurring. I noticed that the tooth in the upper jaw which touched the amalgam in the lower was gold-capped. The light experienced was of a canary yellow and more like the sensation of a vivid lightning flash (forked lightning) than of any mere luminosity or diffusion of light. So vivid were these subjective flashes that my first thought was that there had been lightning, but on the day in question there was no lightning, thunder or rain.

The first explanation that occurred to me was that this was a case of "contact electricity" (Kelvin), that the dissimilar metals—the gold of the upper tooth and the amalgam of the lower—having been in contact in the liquid saliva, produced sufficient current to stimulate the retina heterologously. But the following experiment seemed to be against this; I held between the teeth a copper rod in contact with a silver rod, but no flash of light was experienced when these metals were pressed together.

The next explanation which occurred to me was that the crystallization of the amalgam could give rise to currents sufficiently intense to be the cause of physiological stimulation. Dr. Frank Woodbury kindly told me that he had

known of currents caused in this way being sufficiently intense to give pain in the upper gold-covered tooth when that tooth had an unduly sensitive nerve. I therefore suggest that the electric current thus produced was conducted through the bones and tissues of the head and, encountering the retina en route, stimulated it to give rise to the subjective sensations of light. The possibility of stimulating the retina in situ by electric current was discovered by Ritter in 1800; a constant current passed either transversely across the head in the temporal regions or from the eyelid to the neck will, both at make and break, stimulate the retina causing flashes of light to be perceived. I renewed my acquaintance with these effects by passing the constant current from one dry cell through the eyes transversely across the head; at the make and break the flashes due to this current were slightly less vivid than the flashes due to the tooth-current. On using two dry cells, I obtained flashes closely resembling those from the tooth-current. I am assured that the current from two dry cells would be painful to the inflamed nerve of a tooth.

It is well known that pressure on the eye-ball produces the sensation of light—the phosphene. I noticed that the subjective flashes from two dry cells were not quite so vivid as the phosphene from moderate (non-painful) pressure on the eye-ball. The electrically produced flashes are more diffuse than the phosphene which has a circular outline; the sensations from dry cells or the tooth-current are more truly flashes.

Based on these considerations, I make an attempt to estimate the amount of the tooth-current, say, during the first few seconds of its production. Assuming that the resistance of the head is about 3000 ohms, and that each dry cell can develop 1.5 volts; then, for two cells, we have

$$C = \frac{1.5 \times 2}{3000} = \frac{1}{1000} \text{ of an ampere or one milliampere.}$$

Additions to the Catalogue of Butterflies and Moths collected in the Neighbourhood of Halifax, etc., Nova Scotia.—By Joseph Perrin, McNab's Island, Halifax.

(Read 12 April 1915)

In the Transactions of this Institute, volume xii, part 3 (for 1908-09), Halifax, 1912, pages 258-290, there was published a Catalogue of Butterflies and Moths mostly collected in the neighbourhood of Halifax and Digby, by the present writer and Mr. John Russell, then of the latter place. Since 1909 the writer has continued collecting these insects, and has also received specimens and records of captures from Mr. George E. Sanders, field officer of the Department of Agriculture, entomological laboratory, Bridgetown, Annapolis County, N. S., and from Mr. E. Chesley Allen of Yarmouth, N. S. To those two gentlemen I wish to express my thanks.

In the present supplementary paper there is presented a list of two Butterflies and sixty Moths which were not previously reported; with additional remarks on species before listed, and on such as have been taken at Halifax for the first time. These notes are arranged in two groups: (a) species not hitherto reported from Nova Scotia, and (b) additional notes on species previously reported.

Our previous catalogue contained 60 nominal species and varieties of Butterflies, and 480 of Moths; total 540. The present supplement brings the number up to 62 Butterflies and 540 Moths, total 602.

The nomenclature and arrangement is that of Dr. Harrison G. Dyar's *List of North American Lepidoptera* (Bulletin U. S. National Museum, No. 52; Washington, 1902), and his numbers are prefixed.

All the specimens from McNab's Island (which is situated in the mouth of Halifax Harbour) were taken by myself; other localities have attached the names of those responsible for the records for those places. As before, doubtful specimens have been referred, as far as possible, to specialists for their opinion.

Species not hitherto reported from Nova Scotia.

Order Lepidoptera.

Rhopalocera (Butterflies).

Superfamily Papilionoidea.

Family Pieridæ.

65. *Eurymas eurytheme* Bois. MacNab's Is., Halifax; Sept. 4, 1910, female; Sept. 12, 1913, male. (Perrin).

Family Lycænidæ.

432. *Rusticus scudderi* Edw. South East Passage, Halifax County; July 3, 1911, one male; and August 9, 1914, one male and one female. (Perrin).

Heterocera (Moths).

Superfamily Sphingoidea.

Family Sphingidæ.

706. *Sphinx chersis* Hübner. Digby, N. S.; July 26, 1907. (Russell).

721. *Ceratomia amyntor* Geyer. Bridgetown; June 16, 1913. (Sanders).

Superfamily Bombycoidea.

Family Lithosiidæ.

808. *Hypoprepia fucosa* Hübner. Yarmouth; July 27, 1913. (Allen).

Family Arctiidæ.

828. *Eubaphe læta* Guérin. Deerfield, Yarmouth Co.; July 28, 1913. (Allen).

853. *Estigmene prima* Slosson. South East Passage, Halifax Co.; June 9, 1912. (Perrin).

Family NOCTUIDÆ.

Subfamily Noctuinæ.

960. *Panthea acronyctoides* Walker. MacNab's Is.; June 15, 1912.

1158. *Hadena modica* Guenée. MacNab's Is.; August 20, 1909, at light.

1418. *Platagrotis pressa* Grote. MacNab's Is.; July 15, 1912, at light.

1455. *Agrotis geniculata* Grote & Robinson. Deerfield, Yarmouth Co., August 16, 1911. (Allen).

1788. *Mamestra liquida* Grote. MacNab's Is.; July 14, 1911, at light.

2060. *Tricholita signata* Walker. MacNab's Is.; August 6, 1911.

2078. *Xylina disposita* Morrison. MacNab's Is.; Sept. 26, 1913, at light.

2079. *X. petulca* Grote. MacNab's Is.; Oct. 21, 1912.

2090. *X. antennata* Walker. Bridgetown; Sept. 17, 1913. (Sanders).

2092. *X. grotei* Riley. (*X. cinerosa* Grote.) Bridgetown; Oct. 11, 1913. (Sanders).

2095. *X. innominata* Smith. Bridgetown. (Sanders).

2102. *X. georgii* Grote. Bridgetown; Sept. 24, 1913. (Sanders).

2106. *X. unimoda* Lintner. Bridgetown; Oct. 17, 1913. (Sanders).

——. *Hydroecia micacea* Esp. Bridgetown; Oct. 10, 1912. (Sanders).

2244. *Scopelosoma devia* Grote. Yarmouth; May 17, 1913. (Allen).

Subfamily Catocalinæ.

2905. *Catocala gracilis* Edw. MacNab's Is.; Aug. 21, 1914.

3006. *Erebus odora* Linn. Yarmouth; about June 20, 1906. (Allen).

Subfamily HYPENINÆ.

3039. *Chytolita morbidatis* Guenée. MacNab's Is.; July 8, 1912, at light.

Family NYCTEOLIDÆ.

3083. *Nycteola revayana* Scopoli. MacNab's Is.; Sept. 19, 1914.

Family LASIOCAMPIDÆ.

3221c. *Malacosoma disstria erosa* Stretch. MacNab's Is.; July 8, 1911, at light (Perrin); common at Bridgetown (Sanders).

Family GEOMETRIDÆ.

Subfamily Hydriomeninæ.

3352. *Eustroma triangulata.* Deerfield, Yarmouth Co.; July 28, 1913 (Allen)

Subfamily Sterrhinæ.

3551. *Eois anticaria* Walker. MacNab's Is.; July 7, 1910.

Subfamily Geometrinæ.

3578. *Synchlora ærata* Fab. MacNab's Is.; July 9, 1912, at light.

Subfamily Ennominæ.

3881. *Phigalia titea* Cramer. MacNab's Is.; April 27, 1914.

3898. *Anagoga pulveraria* Linn. MacNab's Is.; July 14, 1907.

3931. *Plagodis phlogosaria* Guenée. MacNab's Is.; July 14, 1914. There is some uncertainty as to the determination of this specimen. It was at first named *Plagodis altruaria* by Dr. Henry Skinner of the Academy of Natural Sciences, Philadelphia, after inspection of the specimen itself. This name does not appear in Dyar's List and possibly is a

new one. Subsequently it was determined as *Plagodis phlogosaria*, Guenée, by Mr. Albert F. Winn of Westmount, Montreal, from a drawing of the specimen.

3947. *Gonodontis obfirmaria* Hübner. South East Passage, Hx. Co.; June 8, 1912. (Perrin).

3956. *Euchlæna obtusaria* Hübner. Deerfield, Yar. Co.; July 8, 1913. (Allen).

3960. *E. johnsonaria* Fitch. Deerfield, Yar. Co.; July 6, 1913. (Allen).

4028a. *Abbotana clemataria transducens* Walker. Dartmouth, Hx. Co.; June, 1907. (Perrin).

Family EPIPLEMIDÆ.

4043. *Callizzia amorata* Packard. Digby; July 16, 1908. (John Bussell).

Superfamily TINEOIDEA.

Family PYRALIDÆ.

Subfamliy Pyraustinæ.

4410. *Phlyctænia terrealis* Treitschke. MacNab's Is.; July 16, 1912.

4451. *Pyrausta rubricalis* Hübner. MacNab's Is.; June 10, 1910.

Subfamily Scopariinæ.

4510. *Scoparia centuriella* Denis & Schiffermüller. Digby; June 23, 1908 (Russell). MacNab's Is.; July 8, 1911 (Perrin).

Subfamily Pyralinæ.

4511. *Aglossa cuprealis* Hübner. MacNab's Is.; June 20, 1911.

Subfamily Schœnobinæ.

4547. *Schœnobias forficellus* Thunberg. MacNab's Is.; July 14, 1911.

Subfamily Crambinæ.

4560. *Crambus hamellus* Thunberg. Yarmouth. (Allen).

4566. *C. unistriatellus* Packard. Yarmouth, July 30, 1912. (Allen).

4574. *C. alboclavellus* Zeller. Yarmouth. (Allen).

4579. *C. hortuellus* Hübner. Yarmouth. (Allen).

4580. *C. perlellus* Scopoli. Yarmouth; August 14, 1911. (Allen).

4583. *C. myellus* Hübner. Yarmouth. (Allen).

4585. *C. vulgivagellus* Clemens. MacNab's Is.; Aug. 10, 1909.

4587. *C. ruricolellus* Zeller. Yarmouth. (Allen).

Subfamily Phycitinæ.

4874. *Ephestia kuehniella* Zeller. MacNab's Is.; Jan. 8, 1915. This pest has only lately been imported into the Island in one of the cereals for family use (Perrin).

Family Pterophoridæ.

4981. *Pterophorus monodactylus* Linn. MacNab's Is. (Perrin). Yarmouth, Sept. 20, 1913 (Allen).

Family Tortricidæ.

Subfamily Olethreutinæ.

5031. *Olethreutes nimbatana* Clemens. Bridgetown; Aug. 9, 1912. (Sanders).

5142. *Eucosma otiosana* Clemens. Bridgetown; Aug. 8, 1912. (Sanders).

5143. *E. similana* Hübner. Bridgetown; Sept. 2, 1912. (Sanders).

5237. *Tmetocera ocellana* Schiffermüller. Bridgetown; Aug. 13, 1913. (Sanders).

Subfamily Tortricinæ.

5335. *Cenopis reticulatana* Clemens. Bridgetown; Aug. 16, 1912. (Sanders).

5382. *Platynota flavedana* Clemens. MacNab's Is.; July 7, 1911.

5391. *Pandemis limitata* Robinson. Bridgetown; Aug. 15, 1912. (Sanders).

5406. *Tortrix fumiferana* Clemens. MacNab's Is.; July 7, 1911; at light.

Family Œcophoridæ.

5894. *Simioscopsis allenella* Walsingham. MacNab's Is.; July. 19, 1911.

Additional notes on species previously reported.

Family Noctuidæ.

975. *Apatela dactylina* Grote. MacNab's Is.; June 26, 1908.

1053. *Harrisimemna trisignata* Walk. One specimen, MacNab's Is.; July 9. 1912.

1067. *Chytonix palliatricula* Guenée. Reported by J. Russell as very common at Digby; but only one specimen has been taken at MacNab's Is., July 11, 1911, in sixteen years of collecting.

Family Geometridæ.

3331. *Venusia comptaria* Walk. Only four specimens of this pretty little moth were taken by J. Russell at Digby, the last being captured on July 20, 1908. Four years later one specimen was collected at MacNab's Is.; July 18, 1912.

3370. *Percnoptilota fluviata* Hübn. Several forms were taken at light on MacNab's Is., in July, 1912.

3390. *Hydriomena tæniata* Stephens. The moth so named by us has been redetermined *Larentia* [*Hydriomena*] *basaliata* Walk., by Mr. A. F. Winn of Montreal from a specimen taken by me at MacNab's Is., August 14, 1914. Mr. Winn says that *H. tæniata* is European, and has not as yet been taken on this side. Dyer considered *H. basaliata* Walk., as a synonymn of *H. tæniata* Stephens. It is merely a question as to the two forms being distinct.

3909. *Therina athasiaria* Walk. MacNab's Is.; May 26, 1910.

Family SESIIDÆ.

4191. *Bembecia marginata* Harris. This species has also been taken at Yarmouth by Mr. E. C. Allen, August 29, 1912.

The Phenology of Nova Scotia, 1914—By A. H. MacKay, LL.D.

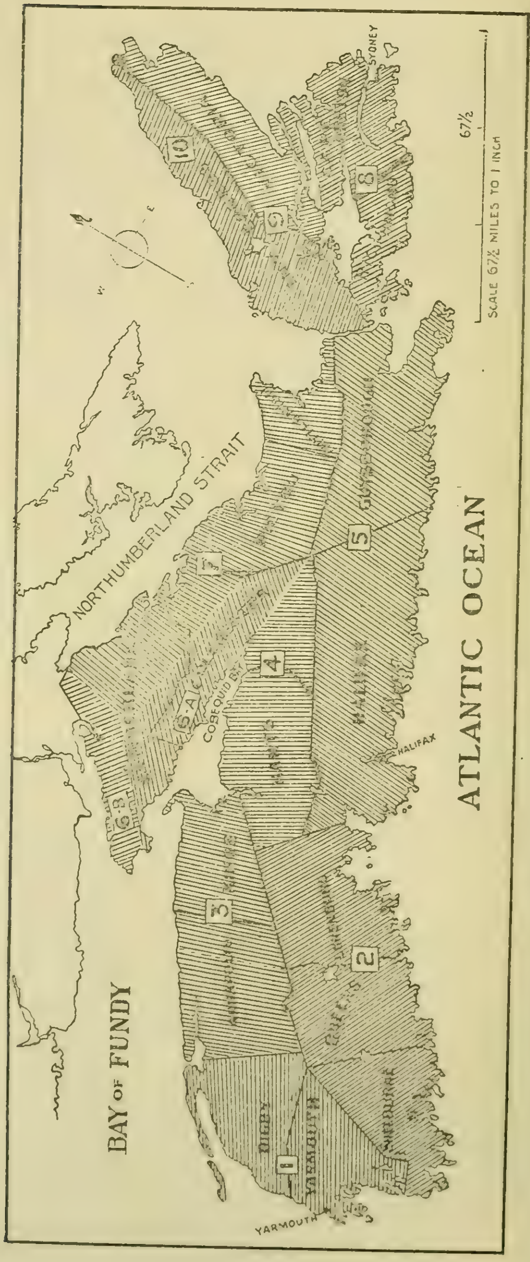
(Read by title 12 May 1915)

These phenological observations were made in the schools of the province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report or bring in the flowering or other specimens to the teachers when they are first observed. The teachers record the first observation and observer, and vouch for the accurate naming of the species. The schedules from 350 of the best schools form the material of the following system of average dates (phenochrons) for the ten biological regions of the Province, and the phenochrons of the Province as a whole. The averaging of these schedules was done by H. R. Shinner, B. A. The * marks dates not averaged.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:—

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's.	" " "
III.	Annapolis and Kings Counties,	(a) Coast, (b) North Mt., (c) Annapolis Valley, (d) Cornwallis Valley, (e) South Mt.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " "
VI.A.	Cobequid Slope (to the south),	" " "
VI.B.	Chignecto Slope (to the northwest),	" " "
VII.	Northumberland Sts Slope (to the n'h)	" " "
VIII.	Richmond & Cape Breton Co's.,	" " "
IX.	Bras d'Or Slope (to the southeast),	" " "
X.	Inverness Slope (to Gulf, N. W.),	" " "

The ten *regions* are indicated on the outline map on the next page.



THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THE PHENOLOGY OF NOVA SCOTIA, 1914.

[Compiled from over 350 local observation schedules.]

Year 1914.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
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For leap year add one to each except January.

		When First Seen. Observation Regions.											When Becoming Common. Observation Regions.										
		1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum. & Col.)	7. N.Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf	Average Dates	Average Dates	1 Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S.Cum. & Col.)	7. N.Cumb, Col, Pictou and Antigonish	8 Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf
1	Alnus incana, Wild	113	104	120	119	117	112	118	121	126	126	118	125	120	112	129	125	121	120	124	130	133	133
2	Populus tremuloides	117	118	131	118	126	127	126	128	125	125	124	131	126	123	136	125	131	128	131	134	140	140
3	Epigea repens, L.	101	100	105	118	114	124	124	127	124	124	116	124	113	110	116	126	123	124	131	134	133	133
4	Equisetum arvense	132	132	130	134	143	134	137	137	137	137	135	141	138	137	136	139	148	139	142	144	146	146
5	Sanguinaria Canadensis	134	127	131	137	139	140	136	145	138	138	137	140	139	130	136	144	143	144	142		144	144
6	Viola blanda	127	125	131	135	132	129	137	139	142	142	134	140	134	127	136	142	139	138	142	146	150	150
7	Viola palmata, *cuculata*	128	128	132	136	135	134	140	142	145	145	137	143	135	133	138	144	141	142	144	149	151	151
8	Hepatica triloba, etc.	123	...	141	130	....	....	138	176	....	....	142	146	129	..	141	137	..		144	179		
9	Acer rubrum	131	127	131	134	131	129	135	137	135	135	133	139	136	134	136	139	136	135	139	143	147	147
10	Fragaria Virginiana...	125	126	129	134	133	134	136	139	139	134	133	141	132	133	136	141	139	146	143	145	146	146
11	" fruit ripe	166	161	161	163	167	167	169	175	176	176	168	174	175	168	170	172	176	175	175	180	....	
12	Taraxacum officinale	132	127	138	137	139	138	140	145	141	141	137	143	139	134	139	142	143	145	145	152	148	148
13	Erythronium Americanum	125	151	145	140	150	143	145	156	148	148	145	151	150	152	149	144	154	152	150	160	150	150
14	Coptis trifolia	137	135	142	141	140	139	142	146	144	147	141	146	142	140	146	145	146	144	145	151	148	148
15	Claytonia Caroliniana	134	145	140	136	141	133	134	147	137	137	139	144	140	151	142	141	145	140	138	153	145	145
16	Nepeta Glechoma	144	135	166	141	145	143	147	143	149	149	146	151	150	144	171	146	147	153	154	154	151	151

THE PHENOLOGY OF NOVA SCOTIA, 1914.—*Continued.*

Year 1914.

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When First Seen. Observation Regions.

		1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S.Cum.&Col.)	7. N.Cumb, Col. Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf	Average Dates
17	Amelanchier Canadensis	146	139	141	143	149	142	143	154	148	148	145
18	" fruit ripe	....	....	....	....	....	....	202	167	....	....	185
19	Prunus Pennsylvanica	147	145	144	145	153	145	144	162	156	156	150
20	" fruit ripe	....	....	....	....	254	....	219	....	....	....	236
21	Vaccinium Can. and Penn.	143	137	146	146	144	142	147	159	156	156	148
22	" fruit ripe	....	*172		....	....	....	219	275	219	219	218
23	Ranunculus acris	152	150	151	155	163	156	154	169	165	165	158
24	R. repens	162	151	158	160	165	167	166	176	171	171	165
25	Trill. erythrocarpum	143	152	145	149	159	152	150	160	157	157	153
26	Rhododendron Rhodora	147	146	148	152	156	151	152	163	162	162	154
27	Cornus Canadensis	159	153	150	154	151	154	150	164	160	160	155
28	" fruit ripe	154	213	..	156	157	.	156	270	138	138	173
29	Trientalis Americana	147	151	150	150	157	150	150	159	147	147	152
30	Clintonia borealis	152	156	149	160	158	162	154	166	176	176	161
31	Calla palustris	154	167	151	158	163	....	161	166	166	166	161
32	Cypripedium acaule	158	155	153	160	163	163	160	172	164	164	161
33	Sisyrinchium angustifolium	156	153	150	157	164	162	160	173	169	169	161
34	Linnæa borealis	161	163	165	163	164	168	163	177	161	161	165
35	Kalmia glauca	147	157	153	152	164	157	153	169	168	168	159
36	Kalmia augustifolia	158	162	161	157	169	155	158	169	164	164	162
37	Cratægus oxyacantha	156	164	150	162	173	156	163	181	....	....	163
38	Cratægus coccinea, etc.	161	157	160	161	166	161	159	172	....	....	162
39	Iris versicolor	160	166	166	171	171	172	170	174	173	173	170
40	Chrysanthemum Leucanthmum	160	161	164	168	172	170	169	175	166	166	167
41	Nuphar advena	162	166	164	173	174	175	163	171	163	163	167

When Becoming Common. Observation Regions.

		Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum & Col.)	7. N.Cumb, Col.Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf
17	Amelanchier Canadensis	150	149	142	144	147	154	147	146	158	155	155
18	" fruit ripe	190	....	....	....	....	....	....	205	176	....	....
19	Prunus Pennsylvanica	154	152	149	147	150	160	150	147	167	159	159
20	" fruit ripe	244	....	....	....	....	263	....	226	....	....	....
21	Vaccinium Can. and Penn.	155	153	142	162	151	151	150	151	162	164	164
22	" fruit ripe	251	....	*206	*212	....	....	....	225	289	252	252
23	Ranunculus acris	165	159	155	158	163	169	164	163	175	172	172
24	R. repens	168	167	155	163	163	168	171	172	177	173	173
25	Trill. erythrocarpum	158	149	155	152	153	161	157	155	172	165	165
26	Rhododendron Rhodora	159	153	149	155	157	160	157	157	169	167	167
27	Cornus Canadensis	161	166	158	155	158	159	160	156	170	166	166
28	" fruit ripe	174	156	213	....	160	161	....	158	280	....	..
29	Trientalis Americana	158	153	155	154	155	165	159	156	163	161	161
30	Clintonia borealis	161	157	161	155	165	166	167	160	175	....	....
31	Calla palustris	163	160	170	151	167	166	....	163	171	160	160
32	Cypripedium acaule	166	164	160	159	167	164	168	166	169	180	170
33	Sisyrinchium angustifolium	166	160	157	155	162	168	168	165	177	173	173
34	Linnæa borealis	167	165	167	170	166	162	167	166	168	170	170
35	Kalmia glauca	164	163	163	157	155	168	163	159	173	169	169
36	Kalmia augustifolia	165	159	165	169	163	162	161	159	172	168	168
37	Cratægus oxyacantha	164	162	168	147	167	174	161	167	....	....	....
38	Cratægus coccinea, etc.	167	169	161	166	167	168	171	161	171	....	....
39	Iris versicolor	172	166	167	171	174	176	176	175	179	170	170
40	Chrysanthemum Leucanthmum	169	166	166	169	174	173	176	174	....	160	160
41	Nuphar advena	171	169	170	168	174	179	....	164	174	169	169

164	159	164	161	161	156	155	164	156	156	158	42 Rubus strigosus	165	167	164	171	163	164	166	160	168	162	162
213	206	161	....	....	....	194	256	233	233	214	43 " fruit ripe	217	213	206	175	....	....	....	195	266	237	237
173	170	172	176	171	....	154	190	172	172	172	44 Rhinanthus Crista-galli	172	177	175	175	....	172	....	157	....	175	175
160	165	157	169	156	168	165	161	170	170	165	45 Rubus villosus	173	172	171	172	173	164	175	169	176	175	175
....	214	228	....	245	....	237	263	288	288	245	46 " fruit ripe	256	....	214	240	....	252	....	245	263	288	288
168	168	175	178	171	....	164	179	163	163	170	47 Sarracenia purpurea	172	171	173	175	....	176	....	170	....	170	170
169	164	150	145	173	173	143	179	170	170	163	48 Brunella vulgaris	164	169	168	155	148	....	178	145	....	175	175
170	166	166	176	177	174	176	168	132	132	163	49 Rosa lucida	167	175	170	172	....	178	....	177	167	150	150
165	167	169	171	167	172	173	172	170	170	169	50 Leontodon autumnale	174	173	172	171	175	171	175	177	178	175	175
169	161	....	144	170	....	159	170	172	172	165	51 Linaria vulgaris	169	174	163	....	152	175	....	161	178	175	175
145	136	138	142	145	142	137	144	142	142	143	52 Trees appear green	150	154	147	144	148	158	155	144	156	150	150
144	144	144	145	151	145	144	160	150	150	148	53 Ribes rubrum cultivated	153	160	149	149	149	160	149	149	164	152	152
....	....	....	....	....	....	205	....	250	250	235	54 " fruit ripe	236	....	....	....	....	....	....	207	....	250	250
154	147	148	147	158	148	146	162	143	143	150	55 R. nigrum cultivated	155	158	154	152	153	160	151	150	168	151	151
....	....	....	....	....	....	185	....	....	....	185	56 " fruit ripe	188	....	....	....	....	....	....	188	....	....	....
146	147	144	148	158	148	145	162	152	152	150	57 Prunus Cerasus	155	152	150	149	152	164	154	149	167	157	157
....	....	....	....	....	....	208	229	....	....	219	58 " fruit ripe	220	....	....	....	....	....	....	210	229	....	....
148	146	146	148	158	152	146	162	155	155	149	59 Prunus domestica	157	156	151	150	153	163	155	151	170	161	161
149	147	147	150	157	154	149	165	157	157	153	60 Pyrus Malus	160	153	153	155	155	165	160	154	172	165	165
158	154	153	161	169	150	159	173	166	166	161	61 Syringa vulgaris	166	161	158	167	165	173	167	163	177	165	165
163	161	167	164	170	167	169	173	168	168	167	62 Trifolium repens	171	170	168	169	168	174	176	174	176	165	165
157	159	163	166	169	169	169	173	172	172	167	63 Trifolium pratense	170	166	166	168	169	173	178	174	178	163	163
166	164	163	172	163	169	174	176	162	162	167	64 Phleum pratense	168	168	166	172	176	172	176	174	....	160	160
181	171	176	....	....	....	185	220	....	....	186	65 Solanum tuberosum	198	194	171	....	....	....	....	204	226	....	....
119	119	122	133	125	133	138	128	133	133	128	66 Ploughing (first of season)	134	124	124	132	140	131	139	141	137	138	138
129	121	134	140	133	143	142	140	140	140	136	67 Sowing	143	143	133	143	146	137	146	146	147	146	146
127	121	135	141	132	137	141	134	137	137	134	68 Potato-planting	140	129	128	145	149	137	147	141	141	141	141
135	127	133	139	141	138	133	130	122	122	132	69 Sheep-shearing	141	138	138	140	147	148	152	148	142	131	131
233	194	....	....	222	....	208	244	222	222	220	70 Hay-cutting	228	244	203	....	....	229	....	214	253	227	227
288	235	232	243	290	....	249	256	267	267	258	71 Grain-cutting	270	290	241	257	253	294	....	252	265	287	287
298	270	255	281	276	....	278	286	288	288	280	72 Potato-digging	288	301	276	271	284	282	....	282	304	298	298
82	85	76	84	97	105	98	114	112	112	92	73a Opening of rivers	....	....	....	....	....	....	....	....	....	....	....
106	104	110	114	110	....	119	125	129	129	116	73b Opening of lakes	....	....	....	....	....	....	....	....	....	....	....
120	122	123	123	121	120	122	124	124	124	122	74a Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
139	132	124	130	125	139	140	133	142	142	135	74b " fly in air	....	....	....	....	....	....	....	....	....	....	....
147	116	129	146	143	....	145	145	137	137	138	75a Last spring frost—hard	....	....	....	....	....	....	....	....	....	....	....
159	145	156	152	150	....	157	166	144	144	153	75b " —hoar	....	....	....	....	....	....	....	....	....	....	....
95	123	71	....	106	....	105	121	128	128	109	76a Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
337	....	....	....	304	....	222	....	....	....	287	76b " —low	....	....	....	....	....	....	....	....	....	....	....
278	283	....	287	291	....	260	265	293	293	281	77a First autumn frost—hoar	....	....	....	....	....	....	....	....	....	....	....
304	298	....	290	308	....	293	294	321	321	303	77b " —hard	....	....	....	....	....	....	....	....	....	....	....
300	298	....	272	308	....	286	300	305	305	297	78a First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
335	336	....	293	315	....	303	315	323	323	318	78b " whiten ground	....	....	....	....	....	....	....	....	....	....	....
343	345	....	....	....	....	341	357	....	....	345	79a Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
*38	....	....	....	....	....	348	366	....	....	357	79b " rivers	....	....	....	....	....	....	....	....	....	....	....
97	83	93	90	93	81	91	96	113	113	96	81a Wild ducks migrating, N	....	....	....	....	....	....	....	....	....	....	....
354	....	....	....	....	....	....	....	....	....	354	81b " S	....	....	....	....	....	....	....	....	....	....	....
97	79	82	88	92	82	87	94	97	97	90	82a Wild geese migrating N	....	....	....	....	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA, 1914.—*Continued.*

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June	181	Dec.	365

For leap year add one to each except January.

When First Seen. Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cumb. & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf	Average Dates	Year 1914.			When Becoming Common. Average Dates	Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cumb. & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf
*354	*253		..	....	....	....	....	304	304	304	82b	Wild geese migrating	S.	....	....	....	....	....	....	....	....	....	....	....
85	90	86	100	100	93	103	103	105	106	97	83	Melospiza fasciata	North.	....	....	....	....	....	....	....	....	....	....	....
88	81	84	86	90	90	91	97	104	105	91	84	Turdus migratorius	"	....	....	....	....	....	....	....	....	....	....	....
94	97	95	98	92	101	84	106	104	104	97	85	Junco hiemalis	"	....	....	....	....	....	....	....	....	....	....	....
118	115	134	133	117	116	139	125	140	140	127	86	Actitis macularia	"	....	....	....	....	....	....	....	....	....	....	....
120	110	115	124	116	....	144	....	121	121	121	87	Sturnella magna	"	....	....	....	....	....	....	....	....	....	....	....
114	118	131	133	110	115	135	128	124	124	123	88	Ceryle Alcyon	"	....	....	....	....	....	....	....	....	....	....	....
125	134	130	147	122	153	136	127	135	135	134	89	Dendrœca coronata	"	....	....	....	....	....	....	....	....	....	....	....
134	129	146	142	131	141	138	157	155	155	143	90	D. æstiva	"	....	....	....	....	....	....	....	....	....	....	....
129	118	122	138	94	128	113	136	126	126	123	91	Zonotrichia alba	"	....	....	....	....	....	....	....	....	....	....	....
143	143	142	144	141	143	141	167	149	149	146	92	Trochilus colubris	"	....	....	....	....	....	....	....	....	....	....	....
121	123	142	139	139	140	132	162	....	....	138	93	Tyrannus Carolinensis	"	....	....	....	....	....	....	....	....	....	....	....
133	115	137	142	....	138	141	159	132	132	136	94	Dolychonyx oryzivorus	"	....	....	....	....	....	....	....	....	....	....	....
145	142	138	143	145	133	145	170	166	166	149	95	Spinis tristis	"	....	....	....	....	....	....	....	....	....	....	....
115	130	135	116	151	....	121	157	152	152	143	96	Setophaga ruticilla	"	....	....	....	....	....	....	....	....	....	....	....
145	164	....	150	....	149	131	158	....	....	149	97	Ampelis cedrorum	"	....	....	....	....	....	....	....	....	....	....	....
133	130	136	126	141	139	135	150	125	125	134	98	Chordeiles Virginianus	"	....	....	....	....	....	....	....	....	....	....	....
107	105	110	115	118	119	117	130	125	125	117	99	First piping of frogs		....	....	....	....	....	....	....	....	....	....	....
116	108	122	124	121	128	132	132	133	133	125	100	First appearance, snakes		....	....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1914.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (Inv. & Victoria).	10. Inverness Slope to Gulf.	Total Year 1914.
	10									10
							56			56
								59		59
								62		62
							63			63
							65^{2}			65^{2}
							66^{13}	66^{2}		66^{15}
			68							68
								70^{2}		70^{2}
							71^{4}			71^{4}
		74								74
	75									75
			76							76
77^{3}	77^{11}	77^{4}	77^{7}	77^{3}				77		77^{29}
			78^{9}	78^{2}		78^{12}				78^{25}
				83						83
							95			95
							97			97
				102		102				102^{2}
			105			105				105^{2}
		109^{2}	109^{4}		109	109^{2}				109^{9}
					110					110
113										113
	118									118
		119								119
			128							128
			129	129^{5}			129^{13}	129^{3}		129^{22}
				130			130			130^{2}
				131			131^{3}	131		131^{5}
							132			132
		133		133						133^{2}
				134						134
			135^{5}			135^{11}		135		135^{17}
136		136		136			136^{2}			136^{5}
	138						138			138^{2}
				141						141^{2}
144										144
	145						145			145
							146			146^{2}
		147	147		147	147^{2}	147^{3}	147		147^{9}

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1914.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (Inv. & Victoria).	10. Inverness slope to Gulf.	Total Year 1913.
148^{3}	148^{14}	148^{3}	148^{10}	148^{8}	148^{2}	148^{16}	148^{13}	148^{3}	.....	148^{72}
......	150	......	150^{2}	......	......	150	150	......	.....	150^{5}
151^{2}	151^{2}	151^{2}	151^{5}	151^{4}	151	151^{12}	151	......	.....	151^{30}
152^{3}	152^{8}	152	152^{4}	152^{3}	152	152^{4}	152^{5}	152	.....	152^{30}
153	153	......	153	153	......	153	153	153	.....	153^{7}
154^{2}	......	......	......	......	......	......	......	......	.....	154^{2}
......	155	......	......	......	......	......	155	......	.....	155^{2}
......	......	......	156	......	......	......	......	......	.....	156
157	......	......	157	......	......	......	......	......	.....	157^{2}
......	158	......	......	......	......	......	......	......	.....	158
......	......	......	......	......	......	......	159	......	.....	159
......	......	......	......	160	......	160	......	160	.....	160^{3}
......	......	161	161^{2}	161^{2}	......	......	161^{4}	161	.....	161^{10}
163^{5}	163^{4}	163^{4}	163^{2}	163	......	163	163^{4}	163	.....	163^{22}
164	164	164	......	......	......	......	164^{5}	......	.....	164^{8}
......	......	......	......	165	......	......	......	......	.....	165
......	......	......	......	166	......	......	......	166	.....	166^{2}
......	167^{2}	167	167	167	......	......	167	......	.....	167^{6}
......	168	......	......	168	......	......	168	168	.....	168^{4}
......	......	......	171	......	......	......	......	......	.....	171
......	......	......	......	173^{2}	......	173	......	173	.....	173^{4}
......	......	......	......	175^{2}	......	175^{3}	......	175^{2}	.....	175^{7}
176^{4}	176^{9}	176^{7}	176^{8}	176^{3}	......	176^{5}	......	176	.....	176^{37}
......	177	......	......	......	......	......	......	......	.....	177
......	......	......	179	......	......	......	......	......	.....	179
......	......	......	......	180	......	......	......	......	.....	180
181	......	......	......	......	......	......	......	......	.....	181
......	199	......	......	......	......	......	......	......	.....	199
......	......	......	......	......	201	......	......	......	.....	201
......	......	......	......	......	207	......	......	......	.....	207
......	......	......	......	......	208	......	......	......	.....	208
......	215	......	......	......	......	......	......	......	.....	215
......	227	......	......	......	227^{2}	......	......	......	.....	227^{3}
......	233	......	......	......	233	......	......	......	.....	233^{2}
......	......	35	......	......	......	......	......	......	.....	235
......	......	......	......	240	......	......	......	......	.....	240
......	......	......	......	......	242^{2}	......	......	......	.....	242^{2}
......	......	......	......	......	......	......	244	......	.....	244
......	......	245	......	......	......	......	......	......	.....	254

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1914.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (Inv. & Victoria).	10. Inverness slope to Gulf.	Total Year 1913.
......	......	246	......	246	246	......	......	......	.....	246^{3}
......	247	247	......	247	247^{2}	......	247	247	.....	247^{7}
......	......	......	......	249	......	......	......	......	.....	249
......	......	250	......	......	250	......	250^{2}	250	.....	250^{5}
......	......	......	......	......	......	......	251	......	.....	251
......	......	......	......	......	......	......	253	......	.....	253
......	......	......	......	......	254	......	......	......	.....	254
......	......	......	......	......	267	......	......	......	.....	267
......	......	......	......	......	273	......	......	......	.....	273
......	......	......	......	......	......	......	274	......	.....	274
276	......	......	......	......	......	......	......	......	.....	276
278	......	......	......	......	......	......	......	......	.....	278
......	......	......	......	......	......	......	294	......	.....	294
......	......	......	......	302	......	......	......	......	.....	302
......	......	......	......	......	......	......	304	......	.....	304
......	308	......	......	308	......	......	......	......	.....	308^{2}
......	......	......	......	309	......	......	......	......	.....	309
......	315	......	......	......	315	......	......	......	.....	315^{2}
......	......	......	......	......	316	......	316	......	.....	316^{2}
......	317^{2}	......	317	......	317	......	......	......	.....	317^{4}
......	......	......	......	......	318	......	......	......	.....	318
......	......	......	......	......	319	......	......	......	.....	319
345	......	......	......	......	......	......	......	......	.....	345
346	......	......	......	......	......	......	......	......	.....	346
348	......	......	......	......	......	......	......	......	.....	348

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:—

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotati ons, such as that recently adopted by the French Zoological Society."

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA.

VOLUME XIV

PART 2

SESSION OF 1915-1916

HALIFAX

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CONTENTS

(Vol. xiv, Pt. 2).

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1915-16.

Annotated List of Birds of Yarmouth and Vicinity, Southwestern Nova Scotia.—By E. Chesley Allen, Yarmouth, N. S.

(Read 8 November 1915)

The following notes are based upon observations made throughout a period of seventeen years.

While the greater part of the observations were made in or within easy walking distance of Yarmouth, a few are on specimens sent in to Yarmouth taxidermists from the adjoining counties of Digby and Shelburne. Where, however, birds are mentioned as having come in to local taxidermists without any mention of the locality from which they came, it should be understood that such birds were taken within the limits of the three counties.

Where particular localities are mentioned, it should be understood that they are in Yarmouth County unless otherwise stated.

The lack of observations on the shore and sea birds, as compared with those on the land birds, should not be taken

as any indication of the scarcity of the former in this vicinity. The writer has given most of his attention to the land birds, and the few observations on the other groups are presented for what they are worth.

Where dates for "first appearance," "becoming common," "last appearance," etc., are given, the number of years on which the average date was reckoned is enclosed in parentheses. Except in two or three cases the writer is not responsible for the birds reported as "taken" or "shot".

The numbers and nomenclature are those used by the American Ornithologists' Union. The list contains 170 species and subspecies.

2. *Colymbus holboellii* (Reinh.). HOLBOELL'S GREBE.—One observation only. A specimen shot at Sand Beach, Jan. 1, 1906.

6. *Podilymbus podiceps* (Linn.). PIED-BILLED GREBE.—Two observations only. A specimen in winter plumage and without ear-tufts taken off Yarmouth, Nov. 16, 1906(?), and brought in to local taxidermist. Another shot at Barrington Passage, by Chas. Weddleton, about Mar. 15, 1915.

7. *Gavia immer* (Brünn.). LOON.—Breeds in all our secluded woodland lakes where there are islands. July 17, 1906, a nest with the usual two eggs was found very close to the water's edge on a small island in a lake near Deerfield. We did not observe the bird leave the nest, but on July 18th we paddled noiselessly around the end of the island and surprised the old bird. She launched herself into the water and splashed along over the surface for about seventy-five yards using her wings as paddles with great effect, then dived to reappear a quarter of a mile up the lake. On the night of July 21st. and also on the 24th and 25th we had much rain,

and both the old birds were much distressed, calling mournfully all night. We visited the nest on the evening of the 26th and found that the lake had risen so that the eggs were half submerged. One old bird was observed a few yards away. More rain followed and next day the eggs were completely submerged. We neither heard nor saw either old bird that day, or thereafter except at a distance and at long intervals. The fact that loons nest so near the water's edge and that they are thus exposed to danger by sudden elevations of the water may in part answer the question asked by one naturalist—Why such wary, strong birds with apparently so few natural enemies do not increase in numbers. July 28, 1911, on the lake at Deerfield, two old loons were noticed close in shore in a gravelly cove. Closer observation showed that they were attended by two very small young. We judged the latter to be not more than a week old. We immediately pushed off in the boat, and rowed between the loons and the open lake. One old bird immediately dived and reappeared out in the lake. He(?) soon disappeared. The other old bird remained with the young until very closely pressed to the shore when she too went under but reappeared just outside the boat where she remained to watch proceedings. The youngsters, when left alone, immediately submerged themselves, reappearing in the same place. This they continued to do for some time, remaining under each time, on an average, fourteen seconds, and above, two or three seconds if undisturbed. Any sudden motion on our part, however, would send them down immediately. They were constantly watching for an opening, and soon separated, swimming rapidly along the shore,

and being most of the time under water. We confined our attention to one of the babies and found that at each reappearance we were gaining upon him. When, however, we judged that his next reappearance would bring him within our grasp he failed to appear; and it was only after waiting a minute or more that we discovered that he had doubled beneath our boat and was away in our rear paddling bravely toward his retreating parent and brother. It is evident that the instinct for self-preservation develops very early in the little loons.

11. *Gavia stellata* (Pont.). RED-THROATED LOON.—One specimen seen, which was shot in the Tusket River, Nov. 23, 1905.

31. *Uria lomvia lomvia* (Linn.). BRÜNNICH'S MURRE.—A specimen was brought to me Feb. 22, 1908, by a gunner who said that they had been about the harbour for two or three weeks.

34. *Alle alle* (Linn.). DOVEKIE.—A few (not more than half a dozen) brought in to local taxidermists each winter.

35. *Megalestris skua* (Brünn.). SKUA.—On May 25, 1910, a specimen from Shelburne Co., consigned to a dealer in Boston was intercepted by the game warden here.

38. *Stercorarius longicaudus* Vieill. LONG-TAILED JAEGER.—One observation. A specimen brought in to local taxidermist in late summer of 1910. This was evidently a young bird as it was in immature plumage.

39. *Pagophila alba* (Gunn.). IVORY GULL.—Dec. 9, 1905, while the coal steamer "Coban" was nearing Sable Island, an ivory gull came aboard. It was captured and brought into Yarmouth for mounting.

46. *Rissa tridactyla tridactyla* (Linn.). KITTIWAKE.—Not more than three observations in seventeen years. All winter birds, brought in to taxidermists.

47. *Larus marinus* Linn. BLACK-BACKED GULL.—Apparently irregular along our coasts in winter, and begins to visit the fresh water lakes as soon as they are open in the spring. A large, and apparently increasing colony breeds on several small islands in Lake George, twelve miles north of Yarmouth. The nests, containing normally three eggs, are situated on the ground. Some are at the roots of stumps, some among the thick bushes, and some among the pebbles on the beach. The shallow hollows are edged with coarse sticks, and lined with tufts of grass, dead leaves, feathers, or other soft material. Two cases have been noted in which the clutch of eggs included one egg of a very pale blue color with obscure lavender markings. Fragments of fishes of large size may be found about the islands. The Bay of Fundy shore is only four miles west of the colony. A visit to the colony June 9, 1912 showed over one hundred nests with eggs, many nests still unused, and about forty young not more than three or four days old. We estimated that there were more than a thousand adult birds in the colony. Another visit was made July 15, 1913. The colony seemed larger than in 1912, nests being found in places not used then. Hatching was practically done, and most of the young were well grown. Many were able to give us a good chase in the boat. We were banding them. They are not, however, rapid swimmers, and good steady pulling soon brings the boat up to them. But their habit of turning suddenly off at right angles makes them difficult to capture.

They never dive to avoid capture, and when caught are able to put up a good fight.

51. *Larus argentatus* Pont. HERRING GULL.—In company with the large colony of Black-backed Gulls at Lake George, is a smaller colony of Herring Gulls, their numbers being roughly in the ratio of one to ten of the former. Their nests seem to be confined to one island, the most heavily wooded of all those used by the gulls.

70. *Sterna hirundo* Linn. COMMON TERN.—Common about our shores in summer. I have never visited any of its reported breeding-places off our coasts.

106. *Oceanodroma leucorhoa* (Vieill.). LEACH'S PETREL.—One was found alive, but unable to rise, on Main St., Yarmouth, Nov. 19, 1909. Three years before, I found the dried body of one at the foot of a ventilating flue in the South End School.

117. *Sula bassana* (Linn.). GANNET.—A specimen in immature gray plumage shot off Chegoggin Point, Oct. 29, 1904, and another in white plumage shot off Yarmouth, Nov. 8, 1904.

129. *Mergus americanus* (Cass.). AMERICAN MERGANSER.—Two male specimens both from Digby Co. sent to taxidermists here. One Feb. 15, 1904, the other Jan. 15, 1912.

130. *Mergus serrator* (Linn.). RED-BREASTED MERGANSER.—A female or young male shot at Arcadia, Dec. 25, 1900. A male in fine plumage shot off Yarmouth, Feb. 28, 1904.

132. *Anas platyrhynchos* Linn. MALLARD.—A male specimen sent to taxidermist here from Shelburne Co., about Nov. 5, 1904. Another brought in the same fall.

133. *Anas rubripes* Brewst. BLACK DUCK.—Remains with us in flocks throughout the winter. Breeds in our inland meadows and in coves along our salt marshes. Pairing is apparently complete by May 15. I usually find young broods about June 15.

137. *Mareca americana* (Gmel.). BALDPATE.—A male (one of three) was shot at Little River, Yarmouth Co., Jan. 9, 1912. Mr. Benj. Doane, local taxidermist, had a female shot near Yarmouth some years before.

139. *Nettion carolinense* (Gmel.). GREEN-WINGED TEAL.—Two males shot at Arcadia, Dec. 20, 1901.

140. *Querquedula discors* (Linn.). BLUE-WINGED TEAL.—One specimen (male) brought in to local taxidermist, from the vicinity of Clarke's Harbour, Apr. 19, 1906.

144. *Aix sponsa* (Linn.). WOOD DUCK.—One specimen (male) sent from Shelburne Co., about Sept. 1, 1908.

146. *Marila americana* (Eyt.). REDHEAD.—One specimen (male) shot at Yarmouth in winter of 1902-3. Another male sent from Seal Island, Feb. 29, 1914.

147. *Marila vallisneria* (Wils.). CANVASBACK.—A male shot at Clarke's Harbour, Oct. 29, 1905.

148. *Marila marila* (Linn.). AMERICAN SCAUP DUCK.—Common along our coast in winter.

151. *Clangula clangula americana* Bonap. AMERICAN GOLDEN-EYE.—Common along our coast in winter.

153. *Charitonetta albeola* (Linn.). BUFFLEHEAD.—Two notes only. A specimen (male) sent from Shelburne Co., Apr. 5, 1906. Another male taken near Yarmouth during Dec. 1909.

162. *Somateria spectabilis* (Linn.). KING EIDER.—Two males sent here from Shelburne Co., Mar. 15, 1906, and Feb. 1, 1909.

166. *Oidemia perspicillata* (Linn.). SURF SCOTER.—They were common along our shore during the winter of 1905. I have no other record of them.

167. *Erismatura jamaicensis* (Gmel.). RUDDY DUCK.—One sent in that was taken at Cape Sable Island, Jan. 5, 1909.

169a. *Chen hyperboreus nivalis* (Forst.). GREATER SNOW GOOSE.—One was shot near Comeau's Hill, Yarmouth Co., about Nov. 1, 1911, in immature plumage.

172. *Branta canadensis canadensis* (Linn.). CANADA GOOSE.—Spring migration of this species is less observed now than a few years ago. I have two mid-winter observations. Two seen Jan. 7, 1907. Flock of forty flying north, Dec. 11, 1910.

173. *Branta bernicla glaucogastra* (Brehm.). BRANT.—I have seen not more than two in seventeen years.

190. *Botaurus lentiginosus* (Montag.). AMERICAN BITTERN.—Found in solitary pairs breeding in our swamps, meadows, and tidal marshes. First appearance (4 years) May 2. Last appearance (4 years) Oct. 14. The mating call is heard as soon as it arrives, and continues as late as June 2. A nest was found at Arcadia, June 20, 1914. The four eggs were laid on a rude mat of rushes in the swamp. The old bird positively refused to be frightened from her nest, and could be lifted or pushed aside without deserting her charge.

194. *Ardea herodias herodias* Linn. GREAT BLUE HERON.—This bird remains about some of our lakes and streams all summer, but I have yet to find them breeding. Earliest recorded appearance, May 28. Last appearance (3 years) Sep. 26.

200. *Florida caerulea caerulea* (Linn.). LITTLE BLUE HERON. —One note only. A specimen seen in the flesh, at taxidermist's, Oct. 21, 1913.

212. *Rallus virginianus* Linn. VIRGINIA RAIL.—One taken at Yarmouth, Nov. 15, 1908.

215. *Coturnicops noveboracensis* (Gmel.). YELLOW RAIL.— One shot at Little River, Yarmouth Co., Dec. 14, 1904.

219. *Gallinula galeata galeata* (Licht.). FLORIDA GALLINULE. —One caught by the foot in a trap near Yarmouth, Dec. 14, 1909.

228. *Philohela minor* (Gmel.). AMERICAN WOODCOCK.— Apparently more common as a fall migrant than a spring migrant. A few breed in this vicinity. In two cases observed, July 13, and July 22, 1910, the young were able to fly just well enough to avoid being caught. Two winter observations,—one remained about an open brook during first half of Feb. 1900, one found dead Jan. 1, 1905. First appearance (5 years) Apr. 4. Last appearance (4 years) Nov. 3.

230. *Gallinago delicata* (Ord.). WILSON'S SNIPE.—Summer resident. Undoubtedly it breeds here, as the aerial nuptial performance of the males may be heard and observed over most of our meadows during the nesting season, but I have yet to find the eggs or young. First appearance (8 years) Apr. 20. Last appearance (5 years) Oct. 30. The "bleating" of the males may be heard from the time of their arrival till June 10.

231. *Macrorhamphus griseus griseus* (Gmel.). DOWITCHER. —Two shot at Crawley's Island, Yarmouth Co., July 7, 1903. The only observation.

239. *Pisobia maculata* (Vieill.). PECTORAL SANDPIPER.—Numbers of them about our coast during first half of Oct. 1908. The only observation.

242. *Pisobia minutilla* (Vieill.). LEAST SANDPIPER.—Mixed flocks of this and the next species are common along our shores in late summer and fall.

246. *Ereunetes pusillus* (Linn.). SEMIPALMATED SANDPIPER.—Common in late summer and fall.

248. *Calidris leucophaea* (Pall.). SANDERLING.—Several seen on Port Maitland Beach, Sep. 7, 1903, and on Sep. 17 of the same year several were brought in to taxidermist here.

254. *Totanus melanoleucus* (Gmel.). GREATER YELLOW-LEGS.—Common during the fall migrations, remaining about our shores till after the middle of Oct.

258. *Catoptrophorus semipalmatus semipalmatus* (Gmel.). WILLET.—Summer resident, but more common during the fall migrations. They show all evidence of breeding in our locality, though I have not yet found nest or young. First appearance (5 years) May 4.

263. *Actitis macularia* (Linn.). SPOTTED SANDPIPER.—Breeds along our shores, streams, and lakes. First appearance (5 years) May 17. Nests with eggs usually found during first ten days of June. Some interesting observations were made in regard to the young along the lake shore at Deerfield. These young birds, which accompany their parents along the gravelly beach, when alarmed, are in the habit of taking refuge in the fringe of low bushes that border the beach along its upper side, and when they once reach this cover it is quite useless to look for them. On three separate occasions, however,

their retreat to the bushes was cut off, and invariably they took to the water, swimming buoyantly and with perfect ease out on the lake. When pursued while swimming they immediately dived, swimming about a foot beneath the surface and for a distance of fifteen or twenty feet. When swimming beneath the surface the feet were not used at all, being carried straight behind, the bird propelling itself by quick, regular, downward beats of its little wings. Though apparently perfectly adapted for locomotion either on or below the surface of the water, the youngster in every case showed restlessness in that element, and constantly watched for an opening to reach the shore and the bush cover. The wing feathers mature very rapidly, and the young are often able to fly while the head and body are still clothed only in down.

270. *Squatarola squatarola* (Linn.). BLACK-BELLIED PLOVER —Occurs here during both spring and fall migrations.

274. *Ægialitis semipalmata* (Bonap.). SEMIPALMATED PLOVER.—Very common during the fall migrations. Often found in company with least and semipalmated sandpipers. I have but one spring observataion, May 3, 1901.

298c. *Canachites canadensis canace* (Linn.). CANADA SPRUCE PARTRIDGE.—Seldom seen near the coast, and said to be becoming less common in the interior. Oct. 31, 1907, one appeared in the street at the north end of the town, and, after posing for several camera exposures, wandered off.

300a. *Bonasa umbellus togata* (Linn.). CANADA RUFFED GROUSE; "BIRCH PARTRIDGE."—Apparently becoming less common. Drumming first heard (5 years) Apr. 5, and may be heard every month till Oct.,

when it becomes common again. Ernest Thompson Seton, in "Redruff," says, "By a strange law of nature, not wholly without parallel among mankind, all partridges go crazy in the November moon of their first year." I have the following notes that may be of interest. At Argyle, Oct. 1, 1900, a young but full grown grouse of that season, flew from somewhere and alighted at my feet as I stood on the doorstep of my boarding house, remaining long enough to allow me to pick it up, when it immediately struggled to escape. At Yarmouth, Oct. 22, 1907, one was seen on the railway track near the harbour, flying up and down and finally disappearing. Another specimen flew in broad daylight through the window of a house on William St. On Nov. 2, 1907, a young grouse was caught while flying about the freight sheds on the Dominion Atlantic Railway wharf, but when liberated flew off. Our Yarmouth specimens show two color phases, red and gray, with intermediate specimens.

——. *Phasianus torquatus* (Gmel.). Ring-necked Pheasant.—A number of these birds (fifty or more) have been liberated here during the last five years, and are said to be multiplying rapidly. The mating call of the male is heard as early as Mar. 26, and is becoming one of the spring sounds of the woods, while reports of young broods come in from all over the western part of the country at least.

316. *Zenaidura macroura carolinensis* (Linn.). Mourning Dove.—Only five observations of this species during seventeen years.

325. *Cathartes aura septentrionalis* Wied. Turkey Vulture.—One shot at Clarke's Harbour, Shelburne Co., fall of 1892*. One shot at Seal Island, Shel-

*This specimen is now in the Provincial Museum, Halifax, accession No. 2196

burne Co., about 1896. One taken at Kemptville. Yarmouth Co., Nov. 10, 1909.

331. *Circus hudsonius* (Linn.). MARSH HAWK.—I find this our most common species in the fall, but uncommon during spring and summer.

332. *Accipiter velox* (Wils.). SHARP-SHINNED HAWK.—Common during the fall migration.

334. *Astur atricapillus atricapillus* (Wils.). GOSHAWK.—Not at all common with us. I have but two observations; both in winter.

337. *Buteo borealis borealis* (Gmel.). RED-TAILED HAWK.—Only four observations; all of birds brought in to taxidermists.

347a. *Archibuteo lagopus sancti-johannis* (Gmel.). ROUGH-LEGGED HAWK.—One shot near Yarmouth, about Nov. 23, 1906.

352. *Haliæetus leucocephalus leucocephalus* (Linn.). BALD EAGLE.—Only one observation in life; one seen Feb. 10, 1906. An average of perhaps one in a season brought in to local taxidermists, from this and neighbouring counties.

360. *Falco sparverius sparverius* Linn. SPARROW HAWK.—Rare here. Two observations only: Oct. 6, 1907; Jan. 17, 1910.

364. *Pandion haliæetus carolinensis* (Gmel.). OSPREY; "FISH HAWK."—With the exception of a pair that shows every indication of breeding about the lakes at Deerfield each season, I have very few records of this species.

365. *Aluco pratincola* (Bonap.). BARN OWL.—On Dec. 16, 1910, Mr. W. H. Robbins, of Tusket, found an owl in his barn. Mr. Robbins endeavored to catch it, but it escaped, and next morning was found

dead outside the barn. The weather at the time was severely cold. The bird proved to be the above species.

366. *Asio wilsonianus* (Less.). Long-eared Owl.—Rare here. One observation only, Dec. 30, 1909.

367. *Asio flammeus* (Pont.). Short-eared Owl.—Rare here. Mr. Doane, taxidermist here, says he has not received more than two or three in twenty years.

368. *Strix varia varia* Barton. Barred Owl.—I have found this to be the most common of our owls.

372. *Cryptoglaux acadica acadica* (Gmel.). Saw-whet Owl.—I have never observed a live specimen of this species, but one or two are taken in this vicinity each winter.

375. *Bubo virginianus virginianus* (Gmel.). Great Horned Owl.—Not uncommon inland.

376. *Nyctea nyctea* (Linn.). Snowy Owl.—A few appear in this vicinity each winter. Earliest recorded date, Oct. 27. Unusually common in the winter of 1902-3. In the fall of 1905 we received our share of the great migratory wave of these owls that swept down across the continent.

377a. *Surnia ulula caparoch* (Mull.). Hawk Owl.—One shot near Yarmouth, Oct. 26, 1905. The only observation in the period covered by this paper.

387. *Coccyzus americanus americanus* (Linn.). Yellow-billed Cuckoo.—A specimen was taken alive and sent to Yarmouth from Cape Sable Island, Oct. 8, 1913.

388. *Coccyzus erythrophthalmus* (Wils.). Black-billed Cuckoo.—Decidedly uncommon here except in one season, the summer of 1900, when they were rather common.

390 *Ceryle alcyon* (Linn.). BELTED KINGFISHER.—Not common. Seems less so than formerly. First appearance (6 years) Apr. 28. Last appearance (8 years) Oct. 16.

393. *Dryobates villosus leucomelas* (Bodd.). NORTHERN HAIRY WOODPECKER.—Rather uncommon resident.

394c. *Dryobates pubescens medianus* (Swains.). DOWNY WOODPECKER.—Resident. A little more common than the last.

400. *Picoides arcticus* (Swains.). ARCTIC THREE-TOED WOODPECKER.—Three observations only: A pair at Argyle, Apr. 6, 1901; a male near Yarmouth, Dec. 27, 1904; another male near Yarmouth, Jan. 20, 1906.

402. *Sphyrapicus varius varius* (Linn.). YELLOW-BELLIED SAPSUCKER.—Summer resident. Not uncommon inland. First appearance (4 years) Apr. 30.

405a. *Ceophlœus pileatus abieticola* (Bangs). NORTHERN PILEATED WOODPECKER.—I have seen this species only twice in life: Apr. 25, 1904, and Oct. 31, 1904. On the former occasion the spring call was heard. It was much like the "if-if-if---" of the Yellow Hammer but the syllable "if" was not repeated as many times as in the Yellow Hammer's call. This bird had, also, the Yellow Hammer's trick of drumming on a dead limb.

421a. *Colaptes auratus luteus* Bangs. NORTHERN FLICKER; "YELLOW HAMMER."—Our nost common woodpecker. Summer resident, but occasionally observed in winter. First appearance (10 years) Apr. 6. Last appearance (8 years) Oct. 29.

420. *Chordeiles virginianus virginianus* (Gmel.). NIGHTHAWK.—Common summer resident. Seems to favor burned forest tracts. First appearance (4 years)

May 28. Last appearance (4 years) Sept. 20. The "booming" may be heard until after the middle of August.

423. *Chœtura pelagica* (Linn.). CHIMNEY SWIFT.—Tolerably common summer resident. As common in woodland as in settled areas. First appearance (11 years) May 15. Last appearance (6 years) Aug. 23.

428. *Archilochus colubris* (Linn.). RUBY-THROATED HUMMINGBIRD.—A few seen each season. First appearance (5 years) May 21. Last appearance (9 years) Sept. 16. Five nests found: July 18, 1904, nest with young well feathered; July 9, 1905, nest with eggs, young appeared July 25; July 10, 1905, another nest just vacated, family still in neighbourhood. July 1, 1906, nest with, probably, eggs; July 21, 1906, another nest with eggs or small young, judging from action of old bird.

444. *Tyrannus tyrannus* (Linn.). KINGBIRD.—Tolerably common summer resident. Seems very irregular as to first appearance, but regular in disappearance. First appearance (4 years) May 24. Last appearance (7 years) Sep. 8. Unusually large flocks seen Sep. 4, 1904, and Sep. 1 to 8, 1907.

459. *Nuttallornis borealis* (Swains.). OLIVE-SIDED FLYCATCHER.—Rather uncommon summer resident. Nests near Yarmouth.

461. *Myiochanes virens* (Linn.). WOOD PEWEE.—Fairly common summer resident in the wooded regions.

463. *Empidonax flaviventris* Baird. YELLOW-BELLIED FLYCATCHER.—Rather uncommon summer resident. Nests in our county.

466a. *Empidonax traılli alnorum* Brewst. ALDER FLYCATCHER.—Common summer resident.

467. *Empidonax minimus* W. M. & S. F. Baird. LEAST FLYCATCHER.—Very common summer resident. May be called the most domestic of our flycatchers, building about our gardens and ornamental trees. First appearance (8 years) May 16. Last appearance (4 years) Aug. 22.

474. *Otocoris alpestris alpestris* (Linn.). HORNED LARK.—One to three observations each winter. Earliest recorded appearance in fall, Nov. 8, 1908. Latest recorded appearance in spring, Mar. 17, 1914.

477. *Cyanocitta cristata cristata* (Linn.). BLUE JAY.—Resident. More common inland than near the coast.

484. *Perisoreus canadensis canadensis* (Linn.). CANADA JAY.—Tolerably common resident. One seen carrying nesting material Mar. 12, 1905.

486a. *Corvus corax principalis* Ridgw. NORTHERN RAVEN.—Not uncommon. Resident.

488. *Corvus branchyrhynchos branchyrhynchos* Brehm. CROW.—Abundant resident. Begins to nest by Mar. 31. More apparent about the town during severe winter weather, and when snow is on the ground.

494. *Dolichonyx oryzivorus* (Linn.). BOBOLINK.—I have found it uncommon in Yarmouth Co., except in one locality—the salt marsh at the head of Yarmouth Harbour, where a number are to be found in the breeding season.

495. *Molothrus ater ater* (Bodd.). COWBIRD.—Five records: May 16, 1903, a male; Aug. 3, 1910, a female; Apr. 21, 1911, a male; Oct. 1, 1911, a male; Oct. 22, 1911, two males.

498. *Agelaius phœniceus phœniceus* (Linn.). RED-WINGED BLACKBIRD.—I have seen but two in seventeen years: Dec. 19, 1908; and Apr. 3, 1899.

501. *Sturnella magna magna* (Linn.). MEADOW LARK.—One taken at Comeau's Hill in fall of 1908. Another at Emerald Island off Shelburne Co., Feb. 20, 1912. This was said to be one of three or four on the island at the time.

507. *Icterus galbula* (Linn.). BALTIMORE ORIOLE.—One shot on Green Island, off Yarmouth, May 10, 1908.

509. *Euphagus carolinus* (Mull.). RUSTY BLACKBIRD.—Rather common summer resident, nesting in our swamps. First appearance (8 years) Mar. 27.

511b. *Quiscalus quiscula æneus* Ridgw. BRONZED GRACKLE.—The following records only.—One Jan. 13, 1904, with English Sparrows. One Oct. 18, 1904. On Oct. 26, 1905, at Mood's Mill, about ten miles east of Yarmouth a flock of over thirty were seen. Feb. 23, 1908, one seen with English sparrows. In summer of 1914 a pair nested at the south end of the town. The same pair returned in 1915.

515. *Pinicola enucleator leucura* (Mull.). PINE GROSBEAK.—Generally considered a winter bird only in Nova Scotia, but my records show observations for every month but September. In July, 1911, Mr. Harrison Lewis, a very careful and accurate observer, found old birds feeding fledgelings on the Mood Road, about ten miles from Yarmouth. During a few fine days in January, 1906, I had an opportunity to observe several in song about an open sunny clearing near Yarmouth. The song resembled that of the purple finch, but was interspersed with a few very robin-like notes. Like the purple finch, too, the grosbeaks were sometimes observed to sing on the wing. I have heard the song since in March, April, and June.

517. *Carpodacus purpureus purpureus* (Gmel.). PURPLE FINCH.—Common summer resident. First appearance very irregular; as late as Oct. 27. Song period from first appearance till middle of July.

—-. *Passer domesticus domesticus* (Linn.). HOUSE or ENGLISH SPARROW.—Abundant resident. They are observed "house hunting" here as early as Mar. 14, and nest building is common during last week in Mar. In the fall months a local migration is noticeable from the town to the country about July 1, and returning about Oct. 1, the attraction to the country being, probably, the grain fields, as clouds of sparrows are seen about them during July, Aug., and Sept.

521. *Loxia curvirostra minor* (Brehm.). AMERICAN CROSSBILL.—Occurs very irregularly here; some seasons common, then none observed for three or four years. I have observed it in Jan., May, Jun., Jul., Aug., and Sep.

522. *Loxia leucoptera* Gmel. WHITE-WINGED CROSSBILL.—Less common than the last. Observed from Aug. to Jan.

528. *Acanthis linaria linaria* (Linn.). REDPOLL.—Though I am keeping all Redpoll notes under this specific name, it is possible that some of my observations may have been of other species of Redpolls. One observation in Dec.; all others confined to Feb. and Mar.

529. *Astragalinus tristis tristis* (Linn.). AMERICAN GOLDFINCH.—Mostly a summer resident, though an occasional winter flock may be seen here. I feel sure from observations at Deerfield that they nest there, though I have not found the nest or young.

533. *Spinus pinus pinus* (Wils.). Pine Siskin.—Irregular here. Common in 1901 and 1902; also in 1906, 1907, 1908. I have seen none since. On June 16, 1907, a male was observed in full song. The song was typically finch-like, being a confused ramble, and uttered while on the wing, the bird spreading wings and tail and displaying all the yellow to the utmost. Song again heard during June, 1908.

534. *Plectrophenax nivalis nivalis* (Linn.). Snow Bunting; Snowflake.—Winter visitor. Very irregular in its abundance from year to year. Some winters none are observed; during others it is common. Unusually common in 1904. Earliest recorded date Nov. 10. Latest date, Feb. 16.

540. *Poœcetes gramineus gramineus* (Gmel.). Vesper Sparrow.—Observed here as a fall migrant only. First appearance (5 years) Oct. 7. Last appearance (4 years) Nov. 30.

542a. *Passerculus sandwichensis savanna* (Wils.). Savannah Sparrow.—Abundant summer resident. First appearance (7 years) Apr. 22. Last appearance (4 years) Oct. 5.

549.1a. *Passerherbulus nelsoni subvirgatus* (Dwight). Acadian Sharp-tailed Sparrow.—Found common about our salt marshes. Doubtless breeds near Bunker's Island and on marsh at the head of Yarmouth Harbour, but up to the present I have not found the nests.

558. *Zonotrichia albicollis* (Gmel.). White-throated Sparrow.—Common summer resident. First appearance (6 years) May 1. Last appearance (8 years) Oct. 18. Song period from first appearance to Oct. 1.

559. *Spizella monticola monticola* (Gmel.). TREE SPARROW.—All my observations of this species are in Feb. and Nov.

560. *Spizella passerina passerina* (Bech.). CHIPPING SPARROW.—Seems irregular in its occurrence here. Most common in Sep. and Oct., less so in May and June, and isolated observations in Nov., Dec., and Jan.

563. *Spizella pusilla pusilla* (Wils.). FIELD SPARROW.—One observation only, Nov. 24, 1907.

567. *Junco hyemalis hyemalis* (Linn.). SLATE-COLORED JUNCO.—Abundant. Mostly summer residents, but a few are seen in winter. Date of becoming common (7 years) Mar. 27. Song period continues to near the end of July. Nesting does not appear to become common till May 1. I have two records of juncos departing from their own simple song and attempting to imitate other birds. In one case the song of the song sparrow was attempted, and in the other that of the robin.

581. *Melospiza melodia melodia* (Wils.). SONG SPARROW.—Abundant. Mostly summer residents, but a few remain all winter. Date of becoming common (13 years) Mar. 28. Nesting not common till May 1. One nest, loosely built, in top of young spruce, ten feet from the ground. Song period normally extends to middle of Aug., but is frequently heard in Oct., with that of other birds which revive their songs again at this season.

583. *Melospiza lincolni lincolni* (Aud.). LINCOLN'S SPARROW.—One record only; Sand Beach, near Yarmouth, June 22, 1906.

584. *Melospiza georgiana* (Lath.). SWAMP SPARROW.—Common summer resident. First appearance (2 years) Apr. 21. Last appearance (2 years) Oct. 8.

585. *Passerella iliaca iliaca* (Merr.). FOX SPARROW.—Observed during four fall migrations and once in spring. First appearance in fall (4 years) Oct. 27 Last appearance in fall (4 years) Nov. 6. Observed a flock, Apr. 7, 1907. They remained about the town for a few days, treating us to their song, which reminded one of that of the purple finch but was shorter.

595. *Zamelodia ludoviciana* (Linn.). ROSE-BREASTED GROSBEAK.—One observation only: a male in song at Mood's Mill, summer of 1906.

608. *Piranga erythromelas* Viell. SCARLET TANAGER.—One taken at Arcadia, three miles from Yarmouth, about 1912. Though I saw the bird I failed to record the date. Two or three others have been received by taxidermists here.

610. *Piranga rubra rubra* (Linn.). SUMMER TANAGER.—A male found dead in the garden of J. Bond Gray, Yarmouth, Apr. 20, 1913. Had been dead two or three days. This specimen is now in the Provincial Museum, Halifax (Acces. No. 4130).

612. *Petrochelidon lunifrons lunifrons* (Say.). CLIFF SWALLOW.—Abundant summer resident. First appearance (10 years) May 17. Last appearance (6 years) Aug. 25. Nest building is common by May 25.

613. *Hirundo erythrogaster* (Bodd.). BARN SWALLOW.—Abundant summer resident. First appearance (10 years) May 3. Last appearance (9 years) Sep. 9. Completed nests containing eggs are not uncommon by June. 1.

614. *Iridoprocne bicolor* (Vieill.). TREE SWALLOW.—Abundant summer resident. First appearance (10 years) Apr. 29. Last appearance (6 years) Aug. 23.

Breeds very commonly with us, nesting in hollow trees and bird-houses.

616. *Riparia riparia* (Linn.). BANK SWALLOW.—A few breed at the lower end of Bunker's Island, near the mouth of Yarmouth Harbour, and doubtless in other suitable localities along our shore, but as they seem to show a decided preference for the sea-shore we seldom see them even a mile or two inland. Latest date observed, Sep. 16.

619. *Bombycilla cedrorum*, Vieill. CEDAR WAXWING.—Most years this species occurs here as a summer resident only. First appearance (4 years) June 1. Last appearance (4 years) Sep. 17. A flock (forty or fifty) remained about Yarmouth during the third week of Nov., 1912. Two dead ones were brought to me. One had the berries of black alder (*Ilex verticillata*) in its throat. During the third week of Feb. 1913, there were many about the town. At this time three dead and one apparently paralyzed were brought to me. The above are my only winter records for this species, and, judging from the number of casualties, they do not seem to make a success of wintering here.

621. *Lanius borealis* Vieill. NORTHERN SHRIKE.—Only three certain records: Dec. 27, 1905; Nov. 10, 1908; Jan. 9, 1910.

624. *Vireosylvia olivacea* (Linn.). RED-EYED VIREO.—Common summer resident, but I am not near enough to its favored haunts to get good dates for its arrival or departure.

626. *Vireosylvia philadelphica* Cass. PHILADELPHIA VIREO. —One record; a specimen shot near Norwood, Yarmouth Co., Jul. 9, 1904.

629. *Lanivireo solitarius solitarius* (Wils.). BLUE-HEADED VIREO.—Four records only: Aug. 24, 1904; Sep. 25, 1904; July 20, 1910; July 23, 1910.

636. *Mniotilta varia* (Linn.). BLACK-AND-WHITE WARBLER.—Common summer resident. First appearance (7 years) May 16. Last appearance (5 years) Sep. 23.

645. *Vermivora rubricapilla rubricapilla* (Wils.). NASHVILLE WARBLER.—I have only one certain record of this species. On the nights of Sep. 9, and 10, 1909, many birds were killed at the light near the month of Yarmouth Harbour. A basket containing sixty-five was handed to me. It contained: Oven-birds 1, Black-throated Green Warblers 7, Black-throated Blue Warblers 1, Parula Warblers 1, Wilson's Warblers 3, Black and White Warblers 1, Yellow Warblers 2, Magnolia Warblers 1, Blackburnian Warblers 4, *Nashville Warblers 1*, Northern Water-thrushes 7, Savannah Sparrows 5, Maryland Yellow-throats 13, Redstarts 13, Red-eyed Vireos 4, Wood Pewee 1.

648a. *Compsothlypis americana usneæ* Brewst. NORTHERN PARULA WARBLER.—Fairly common summer resident. First appearance (3 years) May 15. Latest date seen Aug. 28, excepting observation under Nashville warbler above.

652. *Dendroica æstiva æstiva* (Gmel.). YELLOW WARBLER.—About the town of Yarmouth this is our most common warbler. First appearance (11 years) May 13. Last appearance (7 years) Sep. 9.

654. *Dendroica cærulescens cærulescens* (Gmel.). BLACK-THROATED BLUE WARBLER.—Only five observations in seventeen years: Jul. 12, 1903; Jul. 7 and 9, 1904; Oct. 18, 1906, and Sep. 11, 1909.

655. *Dendroica coronata* (Linn.). MYRTLE WARBLER.—An abundant summer resident, and fairly common winter resident. Date of becoming common in spring (9 years) Apr. 29. It remains common as late as the middle of Oct. Oct. 8, 1909, a partial albino was observed. Entire head and neck, bill, and feet white, a very few dark streaks on body and tail, and wings about half white. The yellow patches, however, of the crown, rump, and sides of breast were retained faintly, and served, with the company the bird was in, to identify it.

657. *Dendroica magnolia* (Wils.). MAGNOLIA WARBLER.—Common summer resident. First appearance (6 years) May 20. Last appearance (3 years) Sep. 26.

659. *Dendroica pensylvanica* (Linn.). CHESTNUT-SIDED WARBLER.—Fairly common summer resident. First appearance (4 years) May 21.

660. *Dendroica castanea* (Wils.). BAY-BREASTED WARBLER.—One observation in seventeen years,—a male in song, June 4, 1911.

661. *Dendroica striata* (Forst.). BLACK-POLL WARBLER.—This warbler makes its appearance about the town of Yarmouth about May 15, and its song may be heard among the ornamental trees for a few days. After this, throughout the breeding season, it may be found in the spruce woods covering the west cape near Yarmouth Harbour.

662. *Dendroica fusca* (Mull.). BLACKBURNIAN WARBLER.—Rather uncommon summer resident. I have seen the old birds feeding young during July. Earliest date seen, May 13.

667. *Dendroica virens* (Gmel.). BLACK-THROATED GREEN WARBLER.—Abundant summer resident. First appearance (9 years) May 17. Last appearance (6

years) Sep. 20. Song period from first appearance to about July 25. I have found them nesting as early as May 21.

672a. *Dendroica palmarum hypochrysea* Ridgw. YELLOW PALM WARBLER.—Rather uncommon summer resident, and nests in our county; but very common during the fall migrations. First appearance (3 years) Apr. 25. Last appearance (6 years) Oct. 15.

674. *Seiurus aurocapillus* (Linn.). OVEN-BIRD.—Common summer resident inland. First appearance (4 years) May 17. Last appearance (3 years) Aug. 27. While camping at Mood's Mill we noticed that the common cry of "Teach-er, Teach-er,----" ceased after Aug. 7, but that the aerial song continued through the month. A nest was found at Carleton, Yarmouth Co., May 24, 1912, nearly completed. It was in a hollow of the ground, and dome-shaped, with the entrance at the side.

675. *Seiurus noveboracensis noveboracensis* (Gmel.). WATER-THRUSH.—Eight or ten observed in seventeen years. At Carleton, Yarmouth Co., a pair was observed feeding young July 4, 1904. Latest observation, Sep. 21.

679. *Oporornis philadelphia* (Wils.). MOURNING WARBLER.—Four observations only: June 1903, one; July 7, 1904, one; July 16, 1904, a female; July 30, 1911, a pair.

681. *Geothlypis trichas trichas* (Linn.). MARYLAND YELLOW-THROAT.—Our most common warbler in low places. First appearance (8 years) May 17. Last appearance (8 years) Sep. 20.

685. *Wilsonia pusilla pusilla* (Wils.). WILSON'S WARBLER.—Five observations only. Seen with young at Deerfield, Aug. 10 and 13, 1908. See note under Nashville warbler.

686. *Wilsonia canadensis* (Linn.). CANADIAN WARBLER.—Rather uncommon summer resident. Evidently breeds here, as it has been seen feeding young several times. Earliest date seen May 24. Latest Aug. 29.

687. *Setophaga ruticilla* (Linn.). REDSTART.—Abundant summer resident. First appearance (5 years) May 19. Last appearance (5 years) Sep. 1.

697. *Anthus rubescens* (Tunstall). AMERICAN PIPIT.—Two observations. A large flock seen Sep. 26, 1906, and another in the fall of 1903.

704. *Dumetella carolinensis* (Linn.). CATBIRD.—An uncommon summer resident in this vicinity. Earliest date seen May 23. Latest, Oct. 3.

722. *Nannus hiemalis hiemalis* (Vieill.). WINTER WREN.—Sep. 30, 1905, one observed; Oct. 26, 1905, one. July 16, 1906, at Mood's Mill, and from then on to the end of the month in that locality one was heard in full song. On July 30 two were heard. These are the only observations of this species.

726. *Certhia familiaris americana* (Bonap.). BROWN CREEPER.—Rare in summer, but during some winters it is rather common, being found in company with the kinglets and chickadees.

727. *Sitta carolinensis carolinensis* Lath. WHITE-BREASTED NUTHATCH.—I have not seen more than a dozen in seventeen years.

728. *Sitta canadensis* Linn. RED-BREASTED NUTHATCH.—More common here than the last, and becomes abundant some years during the fall migrations. On May 24, 1912, at Carleton, an adult was observed feeding a fledgeling. The latter, however, was well developed and almost weaned from parental care. Nesting evidently began early.

735. *Penthestes atricapillus atricapillus* (Linn.). BLACK-CAPPED CHICKADEE.—Abundant resident. Nesting begins as early as Apr. 20. In two cases observed, the sitting bird would allow herself to be stroked while on the nest, and was only driven off by jarring the stump.

740a. *Penthestes hudsonicus littoralis* (Bryant). ACADIAN CHICKADEE.—A record of the comparative abundance of this and the last species, kept carefully for three years, shows that the Acadian chickadee may be found here at any time, but is more common during the winter than the summer months; and that the Black-cap is generally more abundant at any time of year. While I have never found the nest, I have seen them feeding young here in July.

748. *Regulus satrapa satrapa* Licht. GOLDEN-CROWNED KINGLET.—Common winter resident, and a few remain with us throughout the summer. Observed in every month except June. Heard in song in Apr. 1909, and July 1910.

749. *Regulus calendula calendula* (Linn.). RUBY-CROWNED KINGLET.—Fairly common summer resident. First appearance (4 years) Apr. 30.

756. *Hylocichla fuscescens fuscescens* (Steph.). WILSON'S THRUSH; VEERY.—An uncommon summer resident. Occurs very locally and may be found in the same place year after year. I know of only three "tangles" in Yarmouth Co. where I can be reasonably sure of hearing its wild ringing song.

757a. *Hylocichla aliciæ bicknelli* Ridgw. BICKNELL'S THRUSH. —Found in only one locality about Yarmouth, as far as my observations are concerned. A number of them summer on the West Cape near the mouth of the harbour, and probably nest there.

758a. *Hylocichla ustulata swainsoni* (Tschudi). OLIVE-BACKED THRUSH.—Only twice observed. Aug. 11, 1904, one; July 10, 1905, four or five, probably one family.

759b. *Hylocichla guttata pallasi* (Cab.). HERMIT THRUSH.—Common summer resident. First appearance (4 years) Apr. 26. Last appearance (5 years) Oct. 22.

761. *Planesticus migratorius migratorius* (Linn.). AMERICAN ROBIN.—Abundant summer resident. A few remain over all winter. First appearance (10 years) Mar. 25. Become common ((11 years) Mar. 29. Nesting commonly by Apr. 30. Last appearance (8 years) Nov. 14.

766. *Sialia sialis sialis* (Linn.). BLUEBIRD.—Only seven observations in all: five in fall and two in spring. I have been told that they nested here in Yarmouth, and at Carleton. In May, 1911, a pair appeared and paid some attention to nesting boxes on a farm about three miles from Yarmouth but in a day or two they disappeared.

On the Beneficial Action of Certain "Poisons"; and on the Influence of Poisons on Protoplasm and on Enzymes Respectively.—By D. Fraser Harris, M. D., D. Sc., F. R. S. E., F. R. S. C., Professor of Physiology in Dalhousie University, Halifax, N. S.

(Read 22 February 1916)

It would no longer be in accordance with the teachings of physiology to regard such katabolites as CO_2, lactic acid or urea as poisonous or wholly deleterious in the animal body. Just as the heat evolved along with the motion in muscle is not waste or undesirable heat, as much of the heat in the steam-engine is, so the CO_2 evolved by tissue-katabolism is not under all circumstances a deleterious or noxious substance to be instantly eliminated. It may serve some good purpose on its way to be excreted. For, first of all, there is no doubt that it is one of the normal chemical stimuli to the activity of the respiratory centre. Normally CO_2 constitutes 5-6% of the volume of alveolar air. Any rise above normal in the CO_2 concentration in the outer air must retard the elimination of CO_2 from the alveoli; this causes CO_2 in alveolar air to increase and therefore to increase in the blood, and so produce hyperpnoea, thus:—

When CO_2 is 3% of the inspired air, there is acceleration of breathing, when it is 11% of the air, there is distinct hyperpnoea, when it amounts to 15% of the air, there are generalized convulsions, when CO_2 rises to 40% of the outer air, it acts as a direct narcotic to the central nervous system. The converse of all this is that the excessive elimination of CO_2 gives an apnoea, a chemical apnoea (Acapnia).

(2) In the second place, CO_2 causes maximal diastolic filling of the heart when it exists in the blood at 5-8%. This is

its optimum tension; for a rise to 12 to 20% causes diminished systolic output. Conversely, a considerable diminution of CO_2 produces tachycardia at the same time that it stimulates the vaso-constrictor centre. This naturally leads to an unsatisfactory condition of the circulation, for the rapid, weakening heart works badly against increased peripheral resistance. Over 8% of CO_2 in the blood stimulates the vasoconstrictor centre.

(3) It is now definitely known that excess of carbon dioxide in the blood dilates the coronary vessels. Barcroft and Dixon in 1906 wrote; "we have given reasons to show that the liberation of metabolic products from the heart, the chief of which is carbonic acid, controls the vaso-motor changes in the coronary arterioles." This is comparable with the dilator action of muscular katabolites on the arterioles of muscle demonstrated long ago by Gaskell.

(4) Both CO_2 and lactic acid hasten the rate at which arterial blood with low tensions of oxygen gives up its oxygen, that is, is reduced. When hydrogen or nitrogen is bubbled through arterial blood saturated with oxygen, the saturation falls from 100% to 80% at the end of twenty five minutes. but—

Blood containing

0.04% lactic acid falls to about 68%	saturation	in	25	minutes
20.00% CO_2 falls to about 60%	"	"	"	"
0.09% lactic acid falls to about 50%	"	"	"	"
45.00% CO_2 falls to about 25%	"	"	"	"
0.20% lactic acid falls to about 15%	"	"	"	"
100.00% CO_2 falls to about 7%	"	"	"	"

Both CO_2 and lactic acid are, therefore, beneficial to the organism in that they accelerate the reduction of capillary blood. After vigorous exercise there may be 0.07% of lactic acid in the blood.

The Effect of CO_2 on the Rate of Oxidation and of the Reduction of Blood Respectively.

At 37.5°C, the time taken by bubbling hydrogen or nitrogen to reduce oxygen-saturated blood to 50% saturation is twice as long as the time to oxidize blood from zero to 50% to saturation, no CO_2 being present in either case. The oxygen present in the oxidative process is 13.5% volumes, hydrogen being the rest. Barcroft has shown that the addition of CO_2 (six volumes %) to the hydrogen in the reduction process shortens the time (for reduction from full saturation to 50%) and makes it equal to the time for oxidation. The practical import of this is very clear; it means that the velocity of the uptake of oxygen by the pulmonary blood is just the same as that of its loss to the tissues. The rates of pulmonary oxidation and of tissue reduction of haemoglobin are the same, but only in presence of CO_2.

Another example of the beneficial action of a katabolite or poison is urea. Matthews says in his recent text-book: "it is found that the addition of a little urea to artificial perfusion solutions when one is perfusing the heart or other organs, is, as a rule, advantageous. This action is not so well marked in mammals as in teleostean and lasmobranch fishes."

In addition to all this, urea is itself a good diuretic, which circumstance is too obviously of advantage to the organism to merit further remark. Ammonia is a katabolite, but it is a valuable agent for warding off acid intoxication in the body. Certain amines, katabolites, are vaso-dilators and wash acid out of the tissues.

A *poison* may be defined in more than one way. Something that is not a food and not inert in the body, is one good description. A poison might be described as something which compromises or tends to compromise the vitality of the tissues; but unless we qualify the "something," we shall have to include such a thing as a rope tied round the neck producing

suffocation. Comprising the vitality of the tissues by *chemical* means, is inherent in the notion of a poison. Any chemical substance which interferes with the action of the heart or of the respiratory centre to such an extent as to imperil life is a poison. Unquestionably certain drugs are included under this heading. Here we are not thinking of such things as crude acid or alkali which has been swallowed and has destroyed the very tissues themselves; these indeed compromise life and are therefore poisons. Nor are we thinking of such a substance as strychnine which kills in a round-about way by asphyxia. It causes such prolonged inspiratory spasms of the diaphragm that breathing is interfered with and the due entrance of oxygen into the blood and thence to the tissues effectually prevented.

In a sense, strychnine kills as mechanically as does a rope tied round the neck; both ultimately prevent the access of oxygen to the living tissues. It is the narcotic poisons which present the typical problem to the physiological chemist.

Why and how are alcohol, chloroform, ether, morphia, cocaine, and hydrocyanic acid poisons? On what precisely do they act; and is that thing the same substance as that on which perchloride of mercury, for instance, exerts its baneful influence?

Do poisons act on protoplasm or on the products of protoplasmic activity, such as the enzymes? For it is practically certain that a poison must either compromise the proper functional activity of the biogens or living molecules, or it must interfere with the due action of some one or more of the enzymes possessed by or liberated by the protoplasm. Thus for convenience we speak of a protoplasmic poison which kills living protoplasm, and of an enzymic poison which prevents its fermentative activity.

Prof. A. D. Waller, F. R. S. in 1910 investigated the typical case of the poisonous alkaloid aconitine: he found that, whereas aconitine was distinctly poisonous for frog's muscle, it did not in the least restrain the activity of such an enzyme as ptyalin. A 0.01 Normal solution of aconitine after twelve hours' contract with ptyalin and starch was found to have exerted no restraining influence on the enzyme at all. It saccharified starch as rapidly as did an unpoisoned control. Now aconitine is a deadly poison, but to bioplasm itself, not to its product the secretion-enzyme, ptyalin. The relative toxicity of some poisons for frog's muscle is given by Waller (A), and along side it, I place a table of poisons for reductase (B).

A.		B.	
Aconitine	1000.00	Chloroform	5
Quinine	100.00	Ether	
Nicotine	33.00	Morphine	3
Theobromine	18.00	Caffeine	
Caffeine	12.00	Alcohol	2.5
Chloroform	6.00	Quinine	
Ether	0.72	Aconitine	1
Alcohol	0.06		

From these figures we see that whereas aconitine is the most deadly for protoplasm, it is actually the least injurious "poison" for the reducing, respiratory tissue-enzyme, reductase. Again, chloroform is low down as to toxicity in Waller's list; it is at the top of the poisons of reductase.

Once more, take the case of alcohol, a poison to living protoplasm. Protozoa dosed with alcohol are immobilized and die; cilia are killed in water containing alcohol. By the power it has to compromise the activity of the "vital" centres in the Medulla Oblongata, that is by interfering with the innervation of respiratory and cardiac muscle, alcohol in sufficiently high concentration is a poison; but alcohol does not interfere to the same serious extent with pepsin, a secretion enzyme.

No doubt very large draughts of alcohol do inhibit pepsin by precipitating it and so throwing it out of the sphere of chemical activity (solution); but we know quite well that both gastric and intestinal digestion can proceed in the presence of notable quantities of alcohol. Alcohol is a poison both to protoplasm and to its enzymic secretions, but it is more toxic to the former.

As Ehrlich long ago insisted, a poison can exert its influence only so long as it unites chemically with the molecules of the living protoplasm, the biogens; a substance that cannot unite, even temporarily, with the living stuff cannot be a poison; if it cannot get into relations with it, it cannot influence it.

Now it is abundantly clear that poisons do enter into union with the living stuff; chloroform continues to be eliminated by the breath for many hours after the anæsthetized person awakes. It is, of course, by its more or less firm union for the time being with the *living* heart-muscle that chloroform "acts" in high doses so profoundly as a depressant of the cardiac myoplasm which it immobilizes so that the fibres tend to die in diastolic atony.

The respiration of tissues is their chief "vital" characteristic, their taking in oxygen and giving out carbon dioxide—internal respiration— is of the essence chemically speaking of tissue-life.

In a recent research Dr. H. J. M. Creighton and I studied more particularly the inspiratory aspect of tissue respiration, namely that carried out by the reducing ferment of the tissues hitherto called "reductase."

The problem we put to ourselves was this,—Do the alkaloids and other deadly narcotic poisons, substances which kill animals in a very short time, act as inhibitants (poisons) of "reductase" to anything like the same extent? The answer in the negative was so unexpected that we tried to verify it in every possible way. Our method was as follows—the tissue juice from a cat's liver crushed in physiological (1cc) saline was mixed with a dilution of cat's blood in

water one in twenty-five. This—the control—was kept at 40°C and examined from time to time with the spectroscope to ascertain the exact moment at which the oxyhaemoglobin became reduced to haemoglobin. The other tube contained poisoned liver-juice and blood, the juice and the poison having been kept in contact for ten minutes before being added to the blood. Some of the deadliest protoplasmic poisons had very little retarding effect on hepatic reductase, in fact caffeine (the citrate), in 0.01 normal solution prolonged the time of reduction to 24.5 minutes, whereas hyoscine hydrobromide of the same strength only prolonged it to 6.5 minutes, the normal time for the control being 4.5 minutes. Some of our results are given in full in the table below;

TABLE I.

4.5 minutes required for reduction of normal mixture. Time in minutes required for the reduction of mixtures containing 1cc of liver juice, 2cc of blood solution and 1cc of an aqueous solution of the poison having a normal concentration of

Poison	0.1	0.02	0.01	0.001	0.0001	0.00001
Hyoscine hydrobromide........	5.5	7.5	6.5	4.0	3.5	4.5
Cocaine hydrochloride.........	5.5	8.0	8.5	10.0	4.5	......
Morphine sulphate .	6.0	7.0	7.5	6.5	7.5	4.5
Atropine sulphate..	8.0	6.0	6.5	....	......	......
Strychnine sulphate	destroys blood	8.0	6.0	6.5	6.5	......
Quinine hydrochloride.........	....	11.0	9.0	8.0	9.0	6.0
Caffeine citrate....	destroys blood	25.0	24.5	12.5	10.0	0.9
Alcohol...........	10.0	....	10.0	....	9.0	......
Ether............	....	5.0	....	5.0	......	......
Chloroform........	....	10.0	....	9.0	8.0	7.0

The general inference from these and many similar experiments was that, just as Waller had found aconitine had no influence on ptyalin, a secretion enzyme, we found that other deadly alkaloids had only a slight retarding action on the enzyme of internal respiration in the liver, hepatic reductase. An alkaloidal poison is, therefore, not deadly because it compromises tissue respiration, at least on its inspiratory side, as studied in the liver.

Realizing that the narcotic poisons act characteristically on the central nervous system, we next tried the effect of deadly narcotic poisons on brain-juice.

Six and a half minutes was the time required for cat brain-pulp to reduce the oxyhaemoglobin; the following table shows that aconitine only added 2.5 minutes, hyoscine 3.5 and morphine 6.5 minutes respectively.

TABLE II.

Time in minutes required for reduction of mixtures containing 1cc of brain juice, 2cc of blood solution and 1cc of an aqueous solution of the poison having a normal concentration of

Poison	0.1	0.05	0.001	0.00001
Hyoscine hydrobromide......	9.5	....	......	9.5
Morphine sulphate..........	13.0	....	......	13.0
Aconitine..................	....	....	9.0	8.5
Caffeine citrate............	destroys blood	....	......	13.0
Alcohol....................	....	....	11.5	12.0
Ether......................	....	....	13.5	13.5
Chloroform.................	....	....	22.0	12.0

Alcohol, ether and chloroform were all much more inhibitory to the velocity of the tissue respiration of brain than were such lethal poisons as hyoscine, morphine and aconi-

tine. Our inference once again was that the deadly alkaloidal narcotics do not compromise life by interfering seriously with the inspiratory phase of tissue-respiration. But if this be admitted, then the deadly narcotics must be assumed to act on the living molecules of bioplasm, the biogens themselves. The deadly character of the narcotic alkaloids is exerted not on any substance in the outer sphere of influence of the bioplasm, not even on the endo-enzyme of tissue respiration, but on the very centre and citadel of life itself. Doubtless this is much as we should have expected *a priori*; and some critic may remark that it is not throwing much fresh light on protoplasmic poisons; but it at least tells us where the toxicity of alkaloids does *not* preeminently exert its power. This may not be much by itself, but it clears the ground for the next inquiry, namely:

What is it in the biogen for which the alkaloid has affinity, what is it precisely that is immobilized in fatal poisoning?

The poisonous action of alcohol on the lowliest forms of life is well brought out in a set of curious experiments by Professor Woodhead of the University of Cambridge. Using plate-cultures of the phosphorescent bacillus of Byerinck, he actually contrived to photograph the light produced by it in a twenty minutes' exposure. When 7 to 12 per cent. of alcohol was introduced into the culture, the light was abolished altogether; when 5% was introduced, the exposure required was 2.5 hours to obtain the same depth of result as was given by the unpoisoned bacilli in twenty minutes. Here we may say we have the toxic power exerted on the organism as a whole, for we may not in all cases of plants be able to discriminate between protoplasm and enzyme.

In certain animals which produce light, for instance the fire-fly, Photinus pyralis, the light production has actually been attributed to a ferment luciferase an oxidase carrying oxygen to a substance luciferin. It is claimed that these substances can be separated; each alone produces no light, whereas

the intraction of the two does so. It is therefore conceivable that the toxicity of alcohol against light-production might, in the case of animal bioplasm, be exerted on the enzyme and not on the biogens.

One of our general conclusions was thus stated; substances which are known to be rapidly fatal to animals and which depress the vitality of isolated tissues (muscles, nerves, etc.) that is, are deadly protoplasmic poisons, are not poisons in the same sense for reductase from liver or from brain. Another was; substances which are virulent poisons to protoplasm (e.g., aconitine, hyoscine hydrobromide) inhibit reductase no more effectively than substances very much less poisonous to protoplasm, namely, alcohol and caffeine citrate.

We were not prepared for these results; we had expected that such virulent poisons as aconitine, hyoscine and morphine would seriously interfere with tissue respiration. These alkaloids interfere with tissue respiration to a trifling extent compared with what they do as regards putting the vital machinery itself out of action. These deadly poisons compromise the activity neither of such separated substances as the secretion-enzymes, nor the non-separated endo-enzymes, but they do interfere in some way not at present understood with the inmost molecular activity of the biogens themselves. They put their enemy out of action, not by destroying his ammunition but by destroying the factories themselves. Yet the various narcotics differ *inter se* in regard to their toxicity both for neuroplasm and for neural reductase: thus chloroform is about 2.3 times as poisonous as hyoscine towards neural reductase.

Poisons of Bioplasm, of Endo-Enzymes and of Exo-Enzymes.

Certain poisons for bioplasm are poisons also for both its endo-enzymes and its exo-enzymes; such a substance is mercuric chloride. Its toxicity for the whole organism is

well known. Dr. Creighton and I found it fairly poisonous for hepatic reductase: when the normal liver (cat) needed ten minutes to reduce diluted blood, the addition of 0.01 normal $HgCl_2$ prolonged the time to 17 minutes. Waller and others have shown the high toxicity of $HgCl_2$ for ptyalin and for pepsin, both exo-enzymes. Mercuric chloride is therefore poisonous not only for the biogens, but also for their products, the enzymes which remain in the cells as well as for those which leave them.

Another poison HCN or KCN has been examined in regard to this threefold conception of the vital machinery. Its toxicity for the entire organism is notorious. Dr. Creighton and I found it very poisonous towards hepatic reductase; it added 24 minutes to the time (10 minutes) for the reduction of the blood by unpoisoned liver juice. Mr. J. B. Reed° found 1% KCN destroyed all the oxidase (for indo-phenol) in vegetable cells; he further found that the ventral nerve-cord of crawfish after treatment with KCN was quite unable to exhibit any oxidizing power. KCN also prevented any oxidase activity on the part of the leycocytes of human blood. But KCN, except in very high concentration, does not affect the activity of pepsin. KCN is therefore highly toxic towards living matter and towards both the reducing and oxidizing endo-enzymes, but *not* towards secretion-enzymes.

Another substance poisonous for protoplasm and endo-enzyme, but not for secretion-enzyme is arsenious acid (As_2O_3). It is highly toxic for naked protoplasm. Dr. Creighton and I found it added 23 minutes to the time (10 minutes) for hepatic reductase to reduce blood. It was used in 0.01 normal concentration. But against pepsin it has little power except in very high concentration. Ether for instance, does not inhibit the action of lipase.

°The role of oxidases in respiration. J. B. Reed, Jl. Biol. Chem. Aug., 1915.

The following description of quinine not written at all from our present point of view shows that it belongs to the last mentioned group of poisons[1].

"Quinine is frequently called a protoplasm poison because of its action on undifferentiated protoplasm. In small amounts it stimulates movement in Infusoria, but in larger amount paralyzes these minute organisms immediately. The alkaloid also retards the action of some unorganized ferments, especially that of the oxidases."

It appears, then, that all substances which we may call "poisons" do not act in exactly the same manner on the same constituent of the vital mechanism. One might attempt a classification of poisons somewhat as follows:—

1. Substances which act by destroying the histological integrity of the tissues altogether: strong acids, alkalies and nascent elements, as Cl in the "gassing" by Germans. The lesions may be so extensive that death results from shock or from internal haemorrhage.

2. Substances which replace O_2 in air breathed or prevent O_2 gaining access to the Haemoglobin such are CO, CO_2, and CH_4. They kill by asphyxia as truly as if the person had been suffocated or strangled.

3. Substances which cause either spasm of the muscles of respiration or of the diaphragm or paralysis of them, so that the inspirations are suspended, no O_2 reaches the tissues which are asphyxiated, e. g., strychnine and allied alkaloids; also curare which immobilizes muscles by making them inaccessible to nerve impulses.

4. Substances which immobilize the biogens of the neuroplasm of the central nervous system, so that consciousness is ultimately abolished and the respiratory centre paralyzed. All the narcotics proper fall into this group. The vegetable alkaloids are the typical members of this group inasmuch

[1] The Plant alkaloids. Henry. J. and A. Churchill, 1913, p. 171.

as they act specifically on the neuroplasm, but not nearly so directly on the enzymes of tissue-respiration.

5. Substances which both immobilize the biogens of neuroplasm and *also* retard the velocity of action of one or other of the enzymes of internal respiration, namely reductase and oxidase, but do not destroy secretion-enzymes.

Examples of these are chloroform, ether, alcohol, quinine, KCN, As_2O_3.

6. Substances which act injuriously on all the three, the biogens, the endo-enzymes, and the secretion-enzymes. Examples:—Mercuric chloride, silver nitrate, and all salts of heavy metals when in sufficient concentration. Thus Uranium salts as weak as 0.0001% retard ptyalin, and in solution no stronger than 0.008% completely inhibit it.

A STUDY OF THE COW BAY BEACHES.—BY D. S. MCINTOSH, B. A., M. Sc., Professor of Geology, Dalhousie University, Halifax, N. S.

(Read 10 April 1916)

INTRODUCTION.

For many years, the Cow Bay beach has been a summer resort for the residents of Halifax and Dartmouth. The wide expanse of sand and pebbly beach open to the ocean attracts bathers, and the sheltering groves of spruce within a stone's-throw of the sea has become a favourite spot for picnicing parties.

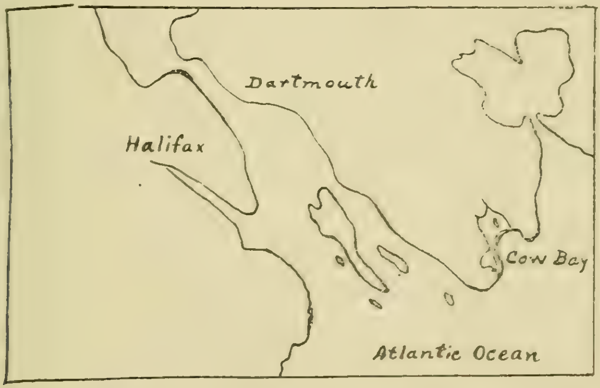


FIG. 1.—LOCATION OF COW BAY.

A drive of six miles by automobile or carriage over a macadamized road from Dartmouth through Woodside and along the harbour-front to Eastern Passage, followed by that over a less level and less smooth road for four miles is the usual way of reaching the locality which lies a few miles to the East of Halifax harbour. The recently constructed "Halifax and Eastern" railroad passes within about a mile of the beach, and will likely have a station near.

Statement of the Problem.

This beach is one of several similar beaches along the Atlantic seaboard of Nova Scotia. The most striking characteristic of this coast is the irregularity of the shore line with its numerous islands—the result of relative coastal subsidence. The channels made by the streams in the quartzites and slates of the area when the land stood higher are now invaded by the sea, and their lower courses are estuaries. In these estuaries, beaches have formed, ponding back fresh or brackish water. Cow Bay beach is neither the largest nor the smallest of these beaches, but has been selected for study on account of the presence back of the present shore-line of a series of beaches older than the modern beach. The purpose of this paper is to account for the present form of this beach—the modern storm beach with the older beaches lying behind. It is hoped, too, that the conclusions arrived at in regard to modern coastal stability are of value, and make the paper one of more than local interest.

General Description.

The general direction of the coast-line east of Halifax is about east-northeast; that of Cow Bay about northeast. The extent of the bay inland from the line of headlands is about a mile. The length of the beach under discussion is about three-fourths of a mile, the eastern corner of the bay having another beach with ponded freshwater. The pond or lagoon back of the beach extends inland for about a mile. It is shallow, and over a large part, the bottom is chiefly drifted sand overlaid by decaying organic material. In the pond is a comparatively large island, the outline and attitude of which is similar to that of the hills in the vicinity. This island appears to have been protected from the sea-waves, even before the present beach was in existence, as it shows no evidence of marine wave action.

On account of the filling up of the pond by material washed over the beach and by wind-borne sand, it is difficult to locate, with any degree of certainty, the outlet at any particular time while the beach was in process of formation. The depth of water and the low cliffs on the north-east side of the island seem to point to the presence there, at some time, of a water course. Doubtless, the outlet has been

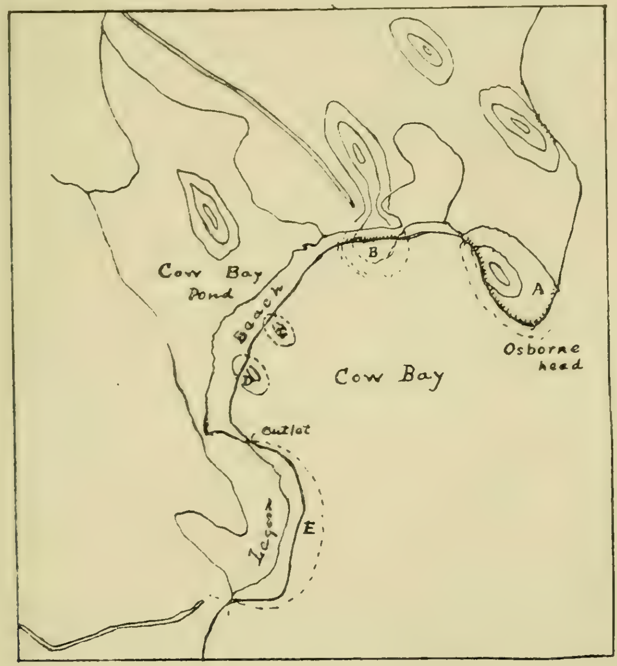


Fig. 2.—Location of present-day and Restored Drumlins.

generally shifted towards the western end of the beach by the prevailing trend of the shore-currents. Within the recollection of the present inhabitants, the water of the pond has been fresh, and drained into the lagoon to the west of the beach (See Fig. 2). About fifteen years ago, however, a storm closed the outlet of the lagoon, the ponded water rose

and burst through at the present outlet, a hundred yards or so from its former exit. A breakwater was then built here to provide a boat harbour. Since then, the water of the pond has been brackish. The lagoon to the west is flooded during high tide, largely through the outlet, but also over a low part of the beach on the western headland.

The surface irregularities of the locality and the surrounding country consist chiefly of rounded elliptical hills with the longer axis approximately south-east and north-west. This direction conforms to that of the glacial scratches on the bed rock. These hills are made up of drift-material, and are therefore drumlins. Some of these drumlins are shown in Fig. 2.

The Drumlins.

These drumlins enter largely into this discussion. Some of them are entire, others are partially wave-eroded, while two show but the wave-sorted base remnant. The western half of the promontory which ends at Osborne Head—drumlin A (Fig. 2)—has the seaward portion wave-eroded so as to produce cliffs. The waves still attack the south-eastern end and are wearing it away, but the cliffs on the side facing Cow Bay are largely grass-covered with shelving beaches extending to the sea. This condition does not, however, seem to have been brought about by elevation of the strand-line, but is rather the result of the seaward building or prograding of the beach, so that the foot of the cliff is now beyond the reach of the waves. Drumlin B (Fig. 2), at the eastern end of the Cow Bay beach, is partly destroyed by wave-action, but the site of the eroded part is shown by the boulder-strewn bottom which extends seawards a hundred and fifty or two hundred feet. It was from a study of this foundation material that it was possible to restore drumlins C, D, and E (Fig. 2). Although the rock of the area is slate, the boulders of the drumlins are quartzite with a sprinkling

of granite from the district to the north. From the eroded part all the finer material has been washed away by the waves, and but the coarsest remains. The boulders in this part of the site, moreover, are not rounded by the waves, but are typically glacial, and they appear not to have been moved from their position in the drumlin, except in so far as they have fallen from an upper level to a lower. A boulder bottom thus fringes the seaward end of the partly eroded drumlins. West of drumlin B about five hundred yards along the beach is a drumlin site C as indicated by the boulder-covered bottom. Nothing but the coarser material remains. A few yards further along towards the west is another drumlin site D. The area that forms the south-western boundary of Cow Bay is also fringed seaward by a boulder-strewn bottom, the remains of a former glacial mound E.

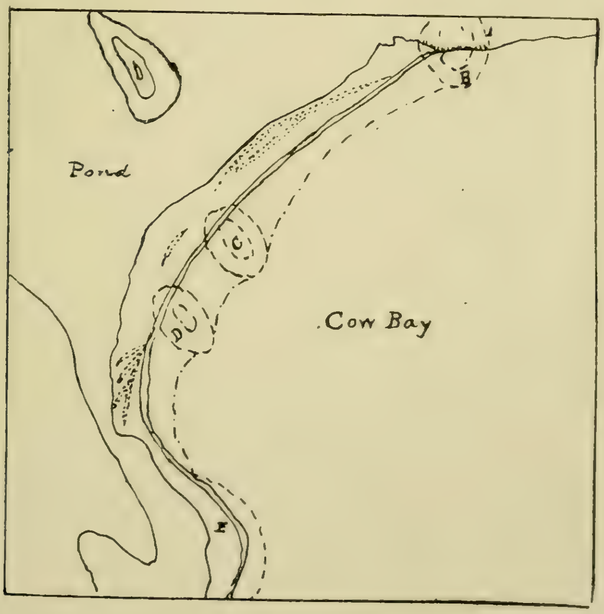


FIG. 3.—BEACHES—MODERN, FULL LINES; OLD, DOTTED LINES; PROBABLE EARLY BEACH, DOT AND DASH LINE.

The Beaches.

The beaches under discussion extend for about three-quarters of a mile with an average width of about four hundred feet. The seaward side is open crescent shaped; the pond side, in general, concave, but with tongues of gravel and pebbles extending into he pond at several places, and pond-made material irregularities in others. These tongues of pebbly material were formed by the action of waves carrying cobbles over the storm beach. Beginning at B going towards the west, (See Fig. 3), the beach for about a hundred and fifty yards has a gentle slope, and beyond the reach of ordinary storms, is ridged with small sand dunes, while the pond side holds scrubby spruces. From this point at the cres , two beaches branch, one a low modern beach, the other an old one. These diverge slightly as they continue westward until at about one hundred yards further west, this old beach divides into two, and the three continue towards the west very gently crescentic for a hundred yards or so. At this point, the farthest back beach is fifty feet from the middle one, and the latter about seventy from the modern. The area here is wooded along the line of beaches with intervening sand patches—the beaches are cobbles. The pondward old beach continues west, coalescing with the other old beach and preserving about the same distance from the modern beach until in a line with the restored outline of drumlin C. In the drumlins *C* and *D* area, the modern beach is low with small grass-covered sand dunes pondward and a low old beach about forty yards back of the modern, and with marshy material to the edge of the pond. From the drumlin site *D* the modern beach continues to rise towards the west until about half-way to the outlet, it is steep as is possible for the cobbles to rest on one another, and is ten and a half feet above the last high tide. This part of the modern beach continues high up to near the outlet. Back of this high modern beach is a series of low old beaches in a

sort of fan shape, spreading out towards the pond outlet and converging towards drumlin *D*. The ends of the fan curve down stream. These beaches lie nine and a half feet below the high modern beach (See Fig. 4). Of the two old beaches to the eastward of drumlin *C*, the furthest back is higher than the modern beach at this part. Here the crest of the modern storm beach is six feet five inches above the last high tide, while the old beach is eight feet two inches to ten feet four inches above the same mark. This latter is, at its highest part, a flat dome-shaped mass of flat cobblestones now lichen-covered (See Fig. 5). Towards the pond side and towards the westward margin, the stones are smaller than on the summit and towards the east.

Storms and their Effects.

The frequency and intensity of storms along this coast for the ten years previous to 1912 is contained in "Wind Data" compiled for the Halifax Ocean Terminals. In this compilation, it is shown that, as one would expect from the latitude of the locality, by far the greatest number of storms has been from the south-west. As this wind blows along the shore, the only effect is seen on the headlands where the beach material is being moved eastward. Where, however, as at Cow Bay the beach is protected from this wind, little effective action of the waves and littoral currents is shown. North-east storms, which are few compared with the south-west, also blow along shore, and have a like effect, unless somewhat east of northeast. The heaviest storm recorded for the ten years blew from this direction with a velocity of over sixty miles an hour. Such a storm would doubtless drive great waves into the bay with an accompanying littoral current. South-east storms are more frequent than north-east, and as the bay lies open and exposed to the full force of the Atlantic waves, the effect should be great, especially when the storm is accompanied by a high tide. It is,

indeed, surprising, at first glance, to see boulders of comparatively small size unmoved from the wave-swept drumlin base. This is owing, however, to the shallowness of the bay for some distance seaward. In heavy storms, a line of breakers is formed off-shore, and the force of the waves diminished.

Origin of the Beaches.

The material of which the beach is composed came from the easily-eroded glacial mounds, and appears to have been carried largely towards the west. On the seaward side of the present beach were at least two islands *C* and *D* (Fig. 3). It is not unlikely that between *B* and *C* were one or more small islands further seaward that protected the island in the pond from the waves before the beach was formed, and which were early destroyed. While the drumlins *A* and *E* extended further seaward than today, the islands were more sheltered than later. The on-shore storms would, however, act upon them, and their reduction was begun. With shallow water, as today, and a current along the shore, the tendency would be for the waste from the drumlin-heads to be carried in the direction of the current, and to form bars which might eventually tie the drumlins, as in Fig. 3. As the waves cut back the drumlins, these beaches would be driven further towards the pond-head. There was, probably, a channel kept open by the currents for some time between *B* and *C*, but this was gradually driven towards the western end of the beach, until at length the water from the pond emptied into the lagoon. When the drumlins were consumed, or but shreds remained on the rear, the beaches were located slightly seaward of the oldest old beach of today. So much material had by this time accumulated that, under ordinary conditions, the movement of the beaches landward was ended. A violent storm, probably accompanied by a high tide, next swept the shore. Its work was most effective in the wider space between *B* and *C*, and

Fig. 4.—Low Old Beaches.

FIG. 5—HIGH OLD BEACH.

where already the beach was highest. The sand, pebbles, and cobbles were carried by the westerly trending curren. and heavy waves over the high beach and spread to the edge and into the pond, leaving the crest of this highest old beach dome-shaped as at present. This height was not again reached by the waves, and the beach prograded, and another storm beach formed, making the second old beach in this part. This latter forms an arc of a larger circle within the arc of a smaller one, the oldest beach. Prograding has continued to the present modern beach.

In the western part of the beach after the destruction of the drumlins, the force of the waves was reduced by sweeping over the drumlin-base. The seaward old beach is probably of the same age as one of those to the east, while the low ones lying behind seem to have been the result of storms carrying material over a low storm beach through troughs in the beach and into the western part of the pond where it joined the lagoon. The development of a high modern beach has preserved them in their present form.

Evidences of the Age of the Beaches.

The oldest beaches reached their present position when, or soon after, the work of consuming the drumlins was completed. For several year they were, doubtless, like the ordinary beach without vegetation. Now they are fringed with spruce trees. A stump of one of the largest of these trees about two feet in diameter shows one hundred and twenty annual growth rings. The younger old beaches are also bordered with trees but of a smaller size. The low old beaches have, in places, their margin covered with from six inches to a foot of firm marsh-grown peat which must have taken many years to accumulate. The minimum age of the oldest beach may be fixed at about a hundred and fifty years.

Conclusions.

The Cow Bay beaches were the result of wave erosion influenced by littoral currents operating upon the glacial material of islands and hills in and around the bay. The process was mainly that of lateral tying. Until the drumlin islands were consumed the beach retreated; afterwards, it grew seaward. The age of the oldest beach is not less than a hundred and fifty years or thereabouts, however much older it may be.

In connexion with old beaches, there naturally arises the question of elevation or subsidence of the shore-line. The subject is one that has, during the last few years, received a good deal of attention. The statement that the north-eastern coast of North America is at present sinking at the rate of about one foot per century has been disputed. Detailed work has recently been done in several places along this coast, and Dr. Douglas W. Johnson, in an interesting paper,[1] shows that much evidence that has been adduced in support of elevation and of subsidence can be otherwise explained. From his study of the Nantasket area, in collaboration with Mr. W. G. Reed Jr., the conclusion is reached that "no marked changes in the relative position of land and sea have occurred in that locality during the last thousand years at least."

In the Cow Bay area, there appears to be no evidence that necessarily points to elevation of the coast-line. The grassed cliff on the partly eroded drumlin *A*, with its shelving beach, is the result of wave erosion succeeded by prograding of the beach brought about by the accumulation of the abundant material driven in from Osborne head. The highest old beach is the work of a heavy storm. The evidence is strong in favor of this explanation. This beach is, moreover, not higher than the high modern storm beach at the western

1. Douglas W. Johnson, *Fixite de la Cote Atlantique de l'Amerique du Nord* (Annales de Géographie, tome XXI, 1912, pp. 193-212).

end of the bay. And, again, had there been elevation, the lowest old beaches would not be as they are today, just above the high water mark. Nor is there evidence of depression shown by the low old beaches. They resulted from storm action. These beaches are, then, rather the effect of waves upon a stationary coast—one which has remained so for at least a hundred and fifty years.

Acknowledgments.

The writer wishes to thank Mr. James McGregor for the use of "Wind Data", and Dr. Douglas W. Johnson for a copy of his paper on the stability of the Atlantic Coast of North America. More especially does he feel under obligations to Dr. J. W. Goldthwait for valuable suggestions and for photographs (Figs. 4 and 5) which, through the courtesy of the Canadian Geological Survey, he was permitted to use.

THE USE OF SOAPS FOR THE ABSORPTION OF BROMINE VAPOR.
—By HENRY JERMAIN MAUDE CREIGHTON, DR. SC.,
Assistant Professor of Chemistry, Swarthmore College, Swarthmore, Pennsylvania, U. S. A.

(Read 10 May 1916)

The writer has recently had occasion to investigate a large number of solid substances with regard to their power of absorbing bromine vapor. Of the different classes of substances examined, the following may be mentioned: soda lime, infusorial earths, solid alcohols, and soaps. The best results were obtained with soaps.

The absorption capacity of the different substances for bromine was determined as follows: A slow current of air was first bubbled through liquid bromine and then through concentrated sulphuric acid, after which it was passed through a U-tube containing the finely divided absorbent. To the exit of the U-tube was attached a small calcium chloride tube to prevent any loss of moisture. On leaving the U-tube, the air was conducted through a wash bottle containing a solution of potassium iodide and starch. The first appearance of blue colour in the wash bottle indicated the complete saturation of the absorbent with bromine.

During the absorption of bromine vapor by some of the soaps investigated, it was observed that considerable heat was developed in that part of the tube where absorption took place.

In all cases, it was found that the amount of bromine absorbed by the different soaps varied inversely as the rate at which the gas was passed through the absorption tube. For example, when air saturated with bromine was

passed through the absorption tube at the rate of four bubbles per second, "Gold Dust" was found to absorb about one-half its weight of bromine; whereas it was found to absorb 0.883 times its weight of the gas, when the rate was reduced to two bubbles per second. In some cases it was found that a sample of soap, which had become saturated with bromine, was capable of absorbing a further quanity of the gas after being allowed to stand for a time. For instance, a certain sample of "Castile" soap which had absorbed 0.75 times its weight of bromine was found, after an interval of eighteen hours, during which period it had remained in the U-tube, to be capable of taking up a further quantity of bromine, the weight absorbed increasing to 0.964 times the weight of the soap. Further, it was found that the amount of bromine absorbed by different soaps is influenced by the amount of moisture which they contain. Thus, a freshly ground, brown laundry soap, containing a high percentage of sodium oleate and some sodium resinate, was found to absorb 0.983 times its weight of bromine. When the same soap had been dried, it was only able to take up 0.515 times its weight of bromine.

Below is given the maximum weight of bromine absorbed by unit weight of soda lime and a number of different soaps, when air saturated with bromine was passed through the absorption tube at the rate of two bubbles per second:

Soda lime	0.477	gram
"Ivory" soap	0.48	"
"Santo" soap	0.607	"
"Olivette Castile" soap	0.631	"
"Gold Dust"	0.883	"
"White Castile" soap	0.964	"
"Oleate" soap (a brown laundry soap)	0.983	"
Pure sodium resinate	1.068	"
Pure sodium oleate	1.113	"

From the figures in the foregoing table, it will be observed that all the soaps are better absorbents of bromine vapor than is soda lime, a substance commonly employed for this purpose. It will further be noted that those soaps containing a high percentage of sodium oleate, such as "White Castile" soap and pure sodium oleate, and those containing a high percentage of solium oleate and sodium resinate, such as brown laundry soaps and pure sodium resinate, have the greatest capacity for absorbing bromine. It is evident from the values in the foregoing table, that the efficacy of soaps in absorbing bromine vapor is due to the presence of the unsaturated carbon atoms of oleic and resin acids.

In view of the large capacity of soaps prepared from oleic and resin acids for absorbing bromine vapor, the writer recommends their use in the laboratory for this purpose, and suggests that such soaps, or pure sodium oleate or sodium resinate, might be employed with advantage in masks as protection against breathing bromine vapors.

The Distribution of the Active Deposit of Radium in an Electric Field.—By G. H. Henderson, M. A., Instructor in Physics, Dalhousie University,* Halifax.

(Read 10 May 1916)

I. Introductory.

The experiments described in this paper were suggested by the results of a previous investigation, by the writer[1], of the analogous problem for thorium. In the former paper it was shown that all the active deposit particles (or rest-atoms) of thorium could be collected on the negative electrode in a strong electric field. Hence all the rest-atoms, at least at the end of their recoil, are positively charged.

In the case of radium, however, early investigators found that only from 90 to 95% of the total active deposit was positively charged. But their results were little more than qualitative in nature. More recently Eckmann[2] came to the conclusion that 98% of the rest-atoms were positively charged and the remaining 2% negatively charged. The experiments of Walmsley[3] seemed to show that, even in the strongest fields, the fraction of the rest-atoms which was positively charged reached a maximum, leaving a small fraction uncharged. The methods of both experimenters, however, are open to very serious objections; the most important is the fact that they both used a cylindrical testing vessel with a central electrode, and then assumed that the total active deposit was the sum of the deposits obtained on it when first cathode and then anode. They thus neglected the considerable amount of deposit which collected on the case of the vessel itself.

*Contributions from the Science Laboratories of Dalhousie University [Physics].

1. Henderson, Trans. N. S. Inst. Sci., XIV. pt. 1, p. 1.

2. Eckman, Jahr. der. Radioakt., May, 1912.

3. Walmsley, Phil. Mag., Oct., 1914.

The only apparently satisfactory results which remained were those of Wellisch[4]. He found that there was a limiting value to the fraction of the rest-atoms which could be concentrated on the cathode, as the strength of the field was increased. Later[5], he gave .882 as the value (corrected for diffusion) of this limiting fraction when the radium emanation was in an atmosphere of dry air. He found similar limiting values of .882 and .789 when the emanation was in atmospheres of hydrogen and carbon dioxide respectively. He also found that all the rest-atoms were uncharged in an atmosphere of ether vapor, as was found by the writer in the case of thorium. Several experimenters, Wellisch and Bronson[6], Wellisch[4], and Walmsley[3], have shown quite conclusively that no appreciable fraction of the rest-atoms is negatively charged. Hence, according to Wellisch's results, 11.8% of the rest-atoms are formed uncharged in dry air.

In the writer's experiments on thorium it was found that the charged condition of *al* the rest-atoms was the *same* in a pure gas (*i. e.* either all positive or all neutral). and that in a mixed atmosphere the fraction of the rest-atoms positively charged depended on the relative proportions of the constituents of the mixture. The explanation of this seemed to be that the charged condition of the rest-atom depended on what kind of molecules surrounded it.

No such simple explanation seemed applicable to the results of Wellisch. It, therefore, seemed desirable to investigate further the behavior of the rest-atoms of radium.

It was suggested by the writer in the previous paper that the fact that there seemed to be a limit to the fraction of the rest-atoms one could collect on the cathode was due to the fact that air was a mixture. This formed the starting-point of the present investigation. It might perhaps be

3. Walmsley, Phil. Mag., Oct., 1914.
4. Wellisch, Am. Journ. Sci., Oct. 1913.
5. Wellisch, Am. Journ. Sci., Oct. 1914.
6. Wellisch and Bronson, Am. Journ. Sci., May, 1912.

expected that in an atmosphere of pure nitrogen, say, all the rest-atoms would be similarly charged. Experiments carried out in atmospheres of pure nitrogen and oxygen gave approximately the same fractions positively charged as for air, which disposed of this suggestion.

A possible explanation of the results obtained by Wellisch might be found in the type of vessel used. In these investigations Wellisch, as well as the others, used as a testing vessel a cylindrical case with an insulated rod fixed centrally inside it, case and rod serving as electrodes. The great disadvantage of this type of vessel is its non-uniform field. A simple calculation will show that most of the drop in potential between the electrodes takes place near the rod. The presence of ionization still further weakens the potential-gradient in the body of the vessel and increases it near the rod. In the corners at the ends of the cylinder and near the insulating plug, the field is much weaker than even in the body of the vessel. Now, although the average value of the field within the vessel may be such as apparently to prevent recombination, there is a part of the volume of the vessel in which the field is very much weaker than the average and in which recombination might take place to a considerable extent.

To avoid this and other difficulties, the vessel used in the present experiments consisted essentially of two parallel plates surrounded by guard-rings. This type of vessel gives a much more uniform potential-gradient than the cylindrical type. The guard-rings prevent distortion of the field at the edges of the electrodes and also allow the use of insulating material on their outer edges without effect on the field between the real electrodes.

II. Apparatus and Method.

The testing-vessel used in these experiments was a slight modification of the "second type" of vessel, described

previously by the writer. It is shown in plan and elevation in Fig. 1.

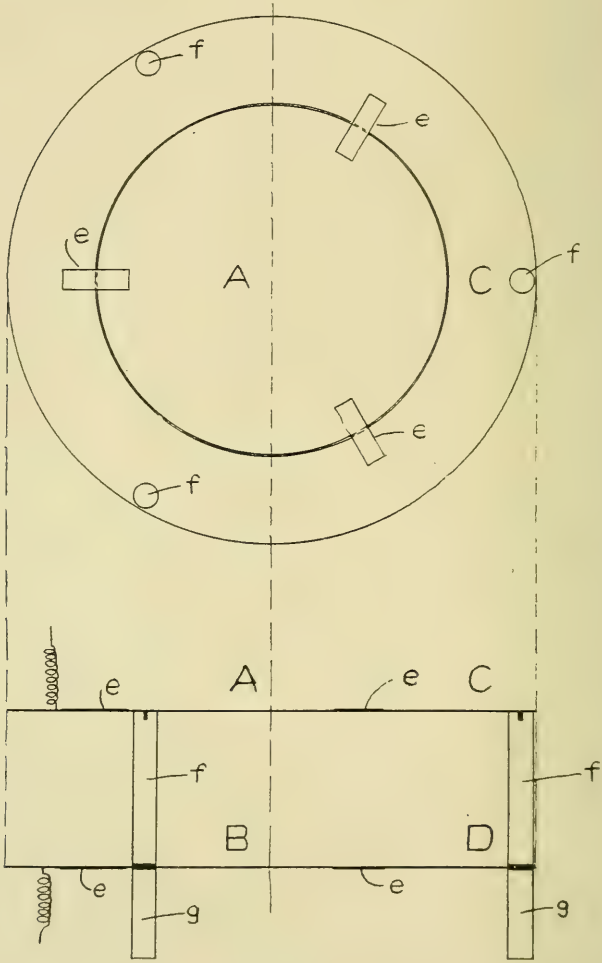


Fig. 1.

The electrodes A and B were two circular brass plates 7.00 cm. in diameter, supported on guard-rings C and D by small lugs e fixed to A and D. The guard-rings, also of

brass, were 7.10 cm. in internal and 10.5 cm. in external diameter. The guard-rings C and D were held parallel 3.00 cm. from one another by three glass rods f. The glass rods G supported the whole on the plate of an air-pump, to which the lower plate was electrically connected. The glass rods F and the outside edges of the guard rings were coated with paraffin to prevent electrical leakage, but no insulating material was near the field between A and B.

To prevent diffusion of recombined rest-atoms from above or below the plates, cotton wadding was placed over C and under D to close up the small space between the rim of the guard-ring and the bell-jar. This was the only essential modification of the previous vessel. The effect of the wadding will be referred to later.

In filling the bell-jar with the required gas the former was exhausted to at least 1 or 2 mm. pressure and the gas was then allowed to pass in through a tube of $CaCl_2$ and a tube of P_2O_5. The bell-jar was again exhausted and the gas allowed to enter a second time. The radium preparation and two small dishes containing P_2O_5 were always kept in the bell-jar, being placed above A.

In this condition the apparatus was allowed to stand from 12 to 24 hours in order to allow sufficient emanation to collect. It should be noted that the greatest quantity of emanation present at any time was minutely small, very much less than that employed by Wellisch. This small quantity would not cause the potential-gradient near the plates to be much greater than that in the body of the vessel. Hence the potential gradient would not be very ununiform. For the last 4½ or 5 hours' exposure of the plates to the emanation the desired potential difference was applied between them. Above a potential difference of 450 volts, i. e. above a potential gradient of 150 volts per cm., the potentials were supplied by a Wimshurst machine run by an electric motor. The values of the potentials obtained

in this way were calculated from the length of the spark gap, by use of the formula:

$$V = 1500 + 30000d$$

where V is the potential difference in volts and d is the length of the spark gap in cms. When the bell-jar was removed the emanation was allowed to escape before the potential was withdrawn. The activities of the plates were then measured in an α-ray electroscope, at from 10 to 25 minutes after the escape of the emanation. The procedure was much the same as that described for thorium in the previous paper, except that correction was, of course, made for decay during the interval of time between removal of the emanation and measurement of the activity.

III. Experimental Results.

While carrying out experiments in air and other gases it was found that a much higher potential-gradient was required to bring over to the cathode a certain percentage of radium rest-atoms, than was needed to bring over the same percentage of thorium rest-atoms. A series of experiments was then made in dry air using high potential-gradients. The results obtained are given in Table I. The first column gives the potential-gradient in volts per cm. The second gives the percentage cathode activity, i. e. the percentage of the total activity collected by the cathode. The percentage of the total positively charged is obtained by subtracting from 100 twice the percentage found on the anode, as there is also deposited on the cathode by diffusion an amount of activity equal to that deposited on the anode. The error in the percentage cathode activity, which depends largely on the error made in measuring the anode activity, is probably somewhat less than 1%. The values of the percentage cathode activity given in Table I are each the mean of several values calculated from different observations.

TABLE I.

Volts per cm.	Percentage cathode activity.
13	92.7
25	93.5
80	94.8
150	94.9
1000	96.2
2000	96.4
4000	96.9
12000	97.8

These results differ in two respects from those found by Wellisch. In the first place a considerably larger fraction of the total activity is found positively charged at the higher voltages than the results of Wellisch indicated. Secondly, there appears to be no limiting value to the percentage brought to the cathode. As the potential-gradient is increased this percentage gradually, though slowly, increases. Thus, the evidence of Wellisch to the contrary, one seems justified in concluding that all the rest-atoms could be brought to the cathode in a sufficiently strong field, and hence that all the rest-atoms are initially positively charged. It is further to be noticed how much more difficult it is to bring over to the cathode the rest-atoms of radium than those of thorium under similar conditions. To obtain 97.8% of the thorium rest-atoms on the cathode a potential-gradient of only about 30 volts per cm. would be required, as compared with a potential gradient of 12,000 volts per cm. in the case of radium. The ionization between the plates was of the same order of magnitude in the two cases.

That the value previously found for the percentage cathode activity of radium was but little above that obtained

by Wellisch, must be ascribed to the fact that in the earlier types of vessels there was no means of preventing the recombined rest-atoms from diffusing into the vessel proper and settling on the plates. That such an effect was appreciable, even in the present vessel where there was little space between the edges of the guard-rings and the bell-jar, was shown in the following manner. Two tinfoil screens were arranged to slip over the plates while in the electroscope. One exposed only the outer part of the anode plate, while the other exposed an equal area at the centre of the anode. If diffusion of recombined rest-atoms took place from outside one would expect to find more activity per unit area near the edge than near the centre of the plates. This would of course be noticeable on the positive plate only. Experiments were performed, leaving out the cotton wadding previously referred to. It was found that the activity near the edge of the anode plate was about 1.4 times that on an equal area near the centre. Similar experiments carried out with the wadding in place gave the activity near the edge practically the same as that on an equal area near the centre.

A few experiments were carried out in atmospheres of hydrogen, carbon dioxide and sulphur dioxide, with the results shown in Table II.

TABLE II.

Potential gradient	Percentage Cathode Activity.		
Volts per cm.	H_2.	CO_2.	SO_2.
150	95.3	89.9	....
4000	96.2	93.1	93.2
12000	....	93.9	....

In hydrogen at a potential gradient of 150 volts per cm. more of the rest-atoms can be collected on the cathode than in air while at 4000 volts per cm. a smaller percentage is collected by the cathode than in air with the same field. With this intense electrical field it is difficult completely to eliminate brush discharge. This would produce water vapor by causing the hydrogen to combine with the traces of oxygen present. That some moisture was present seemed evident from the fact that the P_2O_5 in the vessel was affected to a much greater extent than under a low potential-gradient, or n any other gas tried, though the same precautions were taken in all cases to dry the gas before admitting it to the vessel. Very small quant s of moisture are known to lower considerably the percentage cathode activity. This woul l seem to explain the low values of this percentage found in hydrogen with h gh potential gradients. If the effect of moisture could be eliminated it seems probable that a higher percentage cathode activity would be obtained in hydrogen than in air at all potential gradients. In hydrogen as in air the conclusion seems justified that at a sufficiently high potential-gradient all the rest-atoms could be collected on the cathode.

In carbon dioxide and in sulphur dioxide, it is much more difficult to bring over the rest-atoms to the cathode than in air. It will be noticed that both carbon dioxide and sulphur dioxide at room temperatures are on the border line between vapors and gases. To test if any abrupt change in the behavior of the rest-atoms takes place near the critical temperature, experiments were carried out in carbon dioxide at temperatures of 4°C., 19°C., and 36°C. It seemed a little more difficult to bring the rest-atoms over to the cathode at the lowest temperature, but the difference was very slight.

The fact that the percentage cathode activity is increasing so slowly when it is as low as 93% should perhaps make

one hesitate to conclude that all the rest-atoms could be collected on the cathode with a sufficiently high potential-gradient However, it seems unnatural to suggest any limit other than 100 for the percentage cathode activity, especially in view of the fact that with the highest voltages the percentage was still increasing. Therefore, in the absence of contradictory evidence, it seems reasonable to conclude that in sulphur dioxide and in carbon dioxide all the rest-atoms of radium are initially positively charged.

IV. Conclusions.

In atmospheres of air, hydrogen, carbon dioxide, etc., all the rest-atoms of radium appear to be initially positively charged.

So far no gas or vapor has been discovered in which the radium rest-atoms are not all similarly charged. In this respect the behavior of the rest-atoms of radium is the same as that of the rest-atoms of thorium. The slight differences in this respect which do exist are differences of degree and not of kind.

In a future paper the writer hopes to give some discussion and explanation of these experimental results.

I wish to express my gratitude to Dr. H. L. Bronson for his continual inspiration and advice throughout this investigation.

THE PHENOLOGY OF NOVA SCOTIA, 1915—BY A. H. MACKAY, LL.D.

(Read by title 10 May 1916)

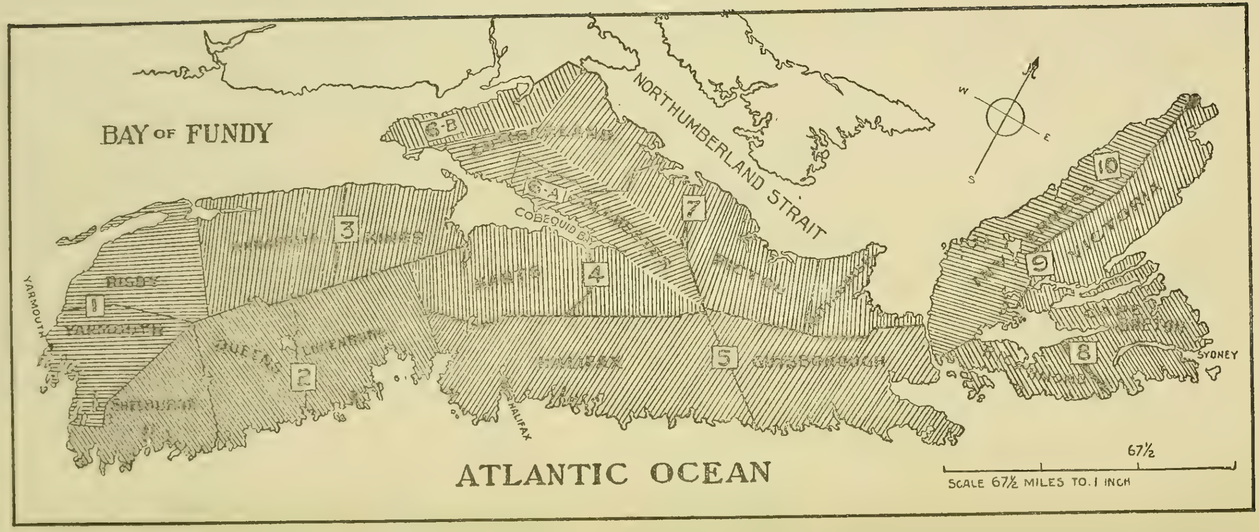
These phenological observations were made in the schools of the province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report or bring in the flowering or other specimens to the teachers when they are first observed. The teachers record the first observation and observer, and vouch for the accurate naming of the species. The schedules from 350 of the best schools form the material of the following system of average dates (phenochrons) for the ten biological regions of the Province, and the phenochrons of the Province as a whole. The selecting and averaging of these schedules was done by Mr. H. R. Shinner, B. A.

The schedules for each year are carefully bound up in a large annual volume which is placed in the Provincial Museum library for the use of students of climatology.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:—

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's.	" " "
III.	Annapolis and Kings Counties,	(a) Coast, (b) North Mt., (c) Annapolis Valley, (d) Cornwallis Valley, (e) South Mt.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " "
VI.A.	Cobequid Slope (to the south),	" " "
VI.B.	Chignecto Slope (to the northwest),	" " "
VII.	Northumberland Straits Slope (to the n'h)	" " "
VIII.	Richmond & Cape Breton Co's.,	" " "
IX.	Bras d'Or Slope (to the southeast),	" " "
X.	Inverness Slope (to Gulf, N. W.),	" " "

The ten *regions* are indicated on the outline map on the next page.



THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THE PHENOLOGY OF NOVA SCOTIA, 1915.

[Compiled from over 350 local observation schedules.]

YEAR 1915.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

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93	105	106	104	108	105	106	108	108	....	105	1 Alnus incana, Wild	111	101	111	112	110	113	110	113	114	115	
114	122	124	122	131	...	116	131	121	....	123	2 Populus tremuloides	129	117	128	....	130	135	...	124	140	127	
86	90	104	104	108	106	115	113	111	....	104	3 Epigea repens, L.	113	100	100	113	113	115	118	123	118	118	
122	130	126	131	136	132	132	129	125	....	129	4 Equisetum arvense	120	127	132	132	133	111	138	136	134	128	
.		131	129	127	....	132	....	137	....	131	5 Sanguinaria Canadensis	136	....	....	134	133	131		138	.	115	
121	12.	127	129	125	131	134	128	130	....	128	6 Viola blanda	134	128	131	133	135	130	134	140	341	139	
125	127	131	132	133	138	136	134	133	....	132	7 Viola palmata, *cucullata*	137	131	134	135	136	137	143	142	130	138	
.	134	140	....	....	....	144	....	127	....	136	8 Hepatica triloba, etc.	142	....	137	144	.			148	.	140	
128	129	128	130	131	134	136	136	137	....	132	9 Acer rubrum	138	134	134	134	134	135	138	141	143	151	
121	126	128	131	128	136	135	131	134	....	130	10 Fragaria Virginiana	137	130	133	136	137	134	141	142	139	144	
158	162	164	16	168	171	176	170	173	....	167	11 " fruit ripe	175	169	171	173	177	176	173	177	177	180	
126	124	130	135	132	134	137	134	136	....	132	12 Taraxacum officinale	139	133	137	136	140	137	141	144	142	144	
158	156	142	139	...	129	136	....	....	....	143	13 Erythronium Americanum	154	163	194	145	142	...	139	142	....	...	
131	136	139	142	134	142	143	137	140	....	138	14 Coptis trifolia	143	137	137	145	147	140	145	147	146	147	...
129	156	132	130	128	125	133	143	132	....	134	15 Claytonia Caroliniana	141	134	164	137	134	133	135	139	154	138	..
143	131	142	139	137	151	143	119	152	.	143	16 Nepeta Glechoma	149	150	139	145	143	142	158	149	155	164	.

THE PHENOLOGY OF NOVA SCOTIA, 1915.—*Continued.*

Year 1915.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
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For leap year add one to each except January.

When First Seen. Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S.Cum.&Col.)	7. N.Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf	Average Dates		Year 1915.	Average Dates	When Becoming Common. Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum & Col.)	7. N.Cumb, Col.Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria	10. Inverness Slope to Gulf
....	139	141	147	149	146	149	152	148	....	145	17	Amelanchier Canadensis	150	149	144	146	149	154	151	153	156	152	....
....	175	....	....	....	....	....	....	161	....	686	18	" fruit ripe	184	....	176	192	....	....	....	....	....	....	....
142	144	145	151	152	150	153	139	155	....	150	19	Prunus Pennsylvanica	155	147	149	150	155	157	156	157	163	163	....
....	214	....	....	....	....	....	236	212	....	154	20	" fruit ripe	237	....	235	237	240	....	....	....	245	230	....
135	138	141	148	148	150	151	155	162	....	148	21	Vaccinium Can. and Penn.	154	142	145	148	156	152	155	158	161	167	....
....	189	....	220	....	....	....	226	232	....	217	22	" fruit ripe	225	....	197	....	228	....	....	....	237	238	....
168	149	150	155	162	149	155	160	160	....	156	23	Ranunculus acris	162	159	156	155	162	166	163	162	166	167	....
154	153	156	163	161	159	165	165	162	....	160	24	R. repens	166	158	160	163	168	166	162	172	170	176	....
146	150	147	153	158	149	152	....	168	....	153	25	Trill. erythrocarpum	141	152	157	156	159	164	153	157	....	174	....
150	147	148	151	154	155	157	159	161	....	154	26	Rhododendron Rhodora	160	157	152	156	164	159	158	162	163	168	....
142	149	151	154	156	158	160	154	161	....	154	27	Cornus Canadensis	161	159	155	158	161	162	164	165	160	167	....
140	159	....	....	....	....	158	221	197	....	195	28	" fruit ripe	183	140	164	....	....	....	....	163	237	212	....
138	151	145	155	153	160	153	155	161	....	152	29	Trientalis Americana	158	155	156	150	160	157	158	158	160	169	....
148	153	149	161	161	161	162	167	166	....	148	30	Clintonia borealis	164	153	158	158	168	165	166	167	166	174	....
165	157	158	166	164	167	157	160	160	....	162	31	Calla palustris	165	170	163	164	169	168	164	162	159	164	....
157	156	160	165	163	164	164	169	170	....	163	32	Cypripedium acaule	164	161	162	164	169	166	167	170	154	167	....
156	157	158	165	167	167	167	167	172	....	164	33	Sisyrinchium angustifolium	168	162	163	162	167	172	171	174	172	172	....
157	163	164	161	171	168	173	173	175	....	166	34	Linnæa borealis	160	162	168	166	170	175	165	177	174	178	....
150	160	160	156	162	154	157	162	163	....	158	35	Kalmia glauca	174	154	161	164	165	168	163	161	167	166	....
160	162	170	168	166	155	169	167	165	....	165	36	Kalmia augustifolia	169	167	167	172	171	165	164	173	169	173	....
156	158	163	167	177	162	163	173	....	....	158	37	Cratægus oxyacantha	169	159	165	165	172	177	....	168	176	....	....
167	161	167	167	168	164	165	....	....	....	165	38	Cratægus coccinea, etc.	169	170	165	169	171	172	....	170	....	....	....
163	163	164	168	172	169	171	174	176	....	169	39	Iris versicolor	173	170	168	169	172	176	175	175	176	178	....
158	162	164	168	173	174	172	171	174	....	168	40	Chrysanthemum Leucanthmum	174	166	170	171	174	177	179	177	172	182	....
163	165	172	167	170	162	170	....	175	....	168	41	Nuphar advena	172	169	172	....	170	174	168	170	....	181	....

159	159	160	166	162	162	161	165	172	....	163	42	Rubus strigosus..................	168	165	167	165	170	167	169	169	170	.	....
...	199	157	....	....	....	...	219	190	....	191	43	" fruit ripe.....	210	...	215	163	.	..	.	229	135	210	....
166	170	177	176	174	164	169	179	220	....	177	44	Rhinanthus Crista-galli..........	183	172	173	180	180	176	177	171	181	237	....
167	164	165	171	168	172	167	163	166	....	167	45	Rubus villosus...................	171	173	171	168	171	166	177	170	169	170	..
....	230	....	177	....	....	204	254	230	....	219	46	" fruit ripe......	239	..	240	243		.	..	211	267	235	....
165	169	....	170	177	....	171	161	....	....	169	47	Sarracenia purpurea........	173	172	173	169	175	179	180	175		.	....
169	172	161	138	....	176	169	...	171	....	165	48	Brunella vulgaris................	168	175	162	165	145	..	180	170		180	....
173	140	175	172	165	177	178	210	....	....	174	49	Rosa lucida......................	179	179	177	181	178	..	181	181	.	...	
167	164	167	172	170	177	170	174	178	....	171	50	Leontodon autumnale..............	166	173	170	162	179	175	174	175	118	....	..
....	168	172	....	....	....	160	177	....	....	169	51	Linaria vulgaris.................	178	..	172	.	...	.	.	169	178	183	..
133	138	135	140	136	140	142	144	137	....	138	52	Trees appear green...............	149	146	147	145	150	145	156	153	149	159	.
144	144	148	150	159	154	153	160	162	....	153	53	Ribes rubrum cultivated	157	148	149	152	154	163	158	158	162	168	..
179	183	....	....	....	....	190	237	185	....	195	54	" fruit ripe	207	....	200	..		.	...	197	243	190	..
151	149	147	155	158	127	156	161	160	....	152	55	R. nigrum cultivated	160	154	155	159	159	162	156	161	164	169	....
....	197	....	....	....	....	191	235	190	....	203	56	" fruit ripe	212	....	203	..	..			209	245	195	..
143	116	146	152	164	155	156	163	159	....	154	57	Prunus Cerasus...................	159	150	152	151	157	168	159	161	165	165	
....	200	....	....	....	....	219	232	165	....	204	58	" fruit ripe	210	...	210	.	...	.	...	220	235	170	
146	149	146	155	162	156	159	161	162	....	155	59	Prunus domestica.................	159	152	153	152	158	167	157	163	166	165	.
149	149	148	155	164	156	160	165	163	....	156	60	Pyrus Malus......................	162	157	156	154	160	168	159	164	167	171	.
158	158	158	164	172	165	164	169	171	....	164	61	Syringa vulgaris.................	161	163	164	164	168	179	169	170	174	...	.
159	159	157	166	170	163	165	161	164	....	163	62	Trifolium repens.................	167	165	166	149	172	176	172	171	166	170	.
149	154	157	164	166	164	166	159	170	....	161	63	Trifolium pratense...............	169	160	163	163	172	170	173	173	172	175	....
165	168	163	172	169	....	177	167	169	....	169	64	Phleum pratense..................	173	171	169	169	173	171	...	180	173	176	.
169	176	160	...	...	....	191	213	185	....	182	65	Solanum tuberosum................	194	171	200	168		.	..	213	225	190	....
94	110	110	133	118	121	130	116	118	....	114	66	Ploughing (first of season)......	128	113	123	127	139	134	136	139	122	128	...
122	119	129	141	121	133	131	129	133	....	139	67	Sowing...........................	139	132	129	140	149	126	145	147	138	144	....
115	120	132	150	121	139	140	124	125	....	129	68	Potato-planting..................	139	126	131	145	160	123	148	148	132	137	..
127	131	135	139	125	130	135	124	115	....	129	69	Sheep-shearing...................	141	138	141	143	154	130	155	145	136	152	....
180	177	....	209	...	....	217	216	215	....	202	70	Hay-cutting......................	215	.	201	200	.		....	223	222	227	
....	230	236	252	...	....	258	253	275	....	251	71	Grain-cutting....................	263	.	277	240	259	...	....	263	258	285	..
....	270	....	272	...	....	267	276	283	....	274	72	Potato-digging...................	279	....	272	230	278	...		281	315	298	..
77	61	....	....	94	97	100	106	95	....	90	73a	Opening of rivers................	.	..	.		.	.					..
85	84	....	....	108	100	101	107	109	....	99	73b	Opening of lakes.................	....	.	..		.	..	.				..
108	119	112	119	120	124	127	104	123	....	115	74a	Last snow to whiten ground.. ...	.										
128	139	147	145	143	145	144	131	137	....	140	74b	" fly in air..........											
112	116	115	115	133	137	128	128	136	....	124	75a	Last spring frost—hard..........											
....	135	138	162	155	....	160	146	159	....	151	75b	" —hoar..........											
....	73	123	129	146	122	148	130	113	....	123	76a	Water in streams—high..........											
....	359	....	271	...	....	....	291	137	....	264	76b	" —low.........											
....	263	239	244	...	....	269	309	293	....	269	77a	First autumn frost—hoar											
....	304	315	268	..	....	299	316	321	....	301	77b	" —hard......											
....	261	285	298	....	....	290	309	305	....	291	78a	First snow to fly in air...........											
....	315	322	300	.	...	307	321	323	....	315	78b	" whiten ground......											
...	336	363	311	...	....	345	362	353	....	345	79a	Closing of lakes.................											
..	365	...	338	.	.	..	349	355		352	79b	" rivers................											
84	93	85	94	98	101	87	92	95	....	92	81a	Wild ducks migrating, N..........											
....	284	..	328	....	.	....	264	.	....	292	81b	" S.........											
84	90	92	77	88	102	88	99	72	....	88	82a	Wild geese migrating N..........											

THE PHENOLOGY OF NOVA SCOTIA, 1915.—*Continued.*

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....	326	350	290	....	....	284	289	264	....	300	82b Wild geese migrating	S.	....	....	....	....	....	....	....	....	....	....	....
89	93	90	98	102	96	97	92	106	....	96	83 Melospiza fasciata	North.	....	....	....	....	....	....	....	....	....	....	....
78	78	88	85	88	87	88	91	125	....	90	84 Turdus migratorius	"	....	....	....	....	....	....	....	....	....	....	....
88	84	89	92	94	....	89	101	94	....	91	85 Junco hiemalis	"	....	....	....	....	....	....	....	....	....	....	....
....	131	122	85	133	132	134	134	128	....	124	86 Actitis macularia	"	....	....	....	....	....	....	....	....	....	....	....
117	121	112	119	128	143	151	124	151	....	129	87 Sturnella magna	"	....	....	....	....	....	....	....	....	....	....	....
118	117	129	106	128	131	130	122	127	....	123	88 Ceryle Alcyon	"	....	....	....	....	....	....	....	....	....	....	....
137	136	138	134	....	133	147	145	125	....	137	89 Dendrœca coronata	"	....	....	....	....	....	....	....	....	....	....	....
134	134	141	145	142	143	141	130	142	....	139	90 D. æstiva	"	....	....	....	....	....	....	....	....	....	....	....
95	131	138	120	127	118	120	117	113	....	120	91 Zonotrichia alba	"	....	....	....	....	....	....	....	....	....	....	....
147	145	145	154	153	148	160	156	138	....	149	92 Trochilus colubris	"	....	....	....	....	....	....	....	....	....	....	....
136	140	136	143	....	145	141	....	156	....	142	93 Tyrannus Carolinensis	"	....	....	....	....	....	....	....	....	....	....	....
131	....	137	120	....	....	122	115	134	....	124	94 Dolychonyx oryzivorus	"	....	....	....	....	....	....	....	....	....	....	....
141	129	145	124	143	154	141	141	141	....	140	95 Spinis tristis	"	....	....	....	....	....	....	....	....	....	....	....
97	153	....	159	142	145	140	153	155	....	143	96 Setophaga ruticilla	"	....	....	....	....	....	....	....	....	....	....	....
151	....	....	153	....	....	142	....	....	....	149	97 Ampelis cedrorum	"	....	....	....	....	....	....	....	....	....	....	....
112	125	130	148	137	129	145	129	137	....	132	98 Chordeiles Virginianus	"	....	....	....	....	....	....	....	....	....	....	....
104	98	106	102	114	114	105	106	108	....	106	99 First piping of frogs	....	....	....	....	....	....	....	....	....	....	....	....
106	103	120	122	126	106	123	115	125	....	116	100 First appearance, snakes	....	....	....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1915.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton	9. Bras d'Or Slope (Inv. & Victoria)	10. Inverness Slope to Gulf.	Total Year 1915.
							89			89
				94^{3}						94^{3}
100^{1}			100							100^{5}
101			101		101^{2}	101				101^{5}
		106				106		106		106^{3}
116^{1}	116									116^{5}
117										117
121^{3}	121									121^{4}
								122		122
		129^{2}		129	129^{2}	129	129	129^{4}		129^{1}
					131	131	131			131^{3}
		140			140^{2}	140^{3}				140^{6}
						141				141
142		142		142^{3}						142^{5}
				143						143
		144			144			144		144^{3}
	145^{5}									145^{5}
147										147
								152		152
	155									155
						156				156
159										159
160i			160			160		160		160^{9}
161^{3}	161^{12}		161^{2}		161			161		161^{19}
162	162				162					162^{3}
163	163		163			163				163^{4}
			164				164			164^{2}
							165^{4}			165^{4}
166	166	166								166^{3}
	167			167^{2}		167^{4}				167^{7}
168^{3}	168									168^{4}
						169				169
170										170
171^{4}	171^{4}	171^{4}	171	171^{3}	171^{2}	171^{5}	171			171^{24}
172	172		172			172^{2}				172^{5}
173			173							173^{2}
				175		175				175^{2}
	176				176					176^{2}
	177	177		177	177	177		177^{8}		177^{13}

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......	178	178^{2}	......	178	......	178	187^{9}	......	......	178^{14}
179^{2}	179	179	......	......	......	......	......	......	......	179^{4}
180	180^{3}	......	......	180	......	......	......	......	......	180^{5}
181	......	......	......	......	......	......	......	......	......	181
......	......	......	......	......	......	188	......	......	......	188
......	189	......	......	......	......	......	......	......	......	189
......	......	......	......	......	......	......	......	198	......	198
......	......	......	......	......	......	201	......	......	......	201
......	......	......	......	......	......	......	......	215	......	215
......	......	......	......	......	......	......	......	229	......	229
......	......	......	233	......	......	......	......	......	......	233
......	......	......	242	......	......	......	......	......	......	242
......	247	......	247	......	......	......	......	......	......	247^{2}
......	......	......	......	......	......	......	......	249	......	249
......	......	......	250	......	......	......	......	......	......	250
......	......	......	......	......	......	......	252	......	......	252
......	......	253	......	......	......	......	......	......	......	253
......	258	......	......	......	......	......	......	......	......	258
......	......	259	......	......	......	......	......	......	......	259
......	......	......	......	......	......	260^{2}	......	......	......	260^{2}
......	265	......	......	......	......	......	......	......	......	265
......	......	......	......	......	......	292	......	......	......	292
......	......	......	294	......	......	......	......	......	......	294
......	......	300^{4}	......	......	......	300^{4}	......	......	......	300^{8}
......	......	303^{3}	......	......	......	......	......	......	......	303^{3}
......	......	......	......	......	......	......	304	......	......	304
......	......	305	......	......	......	......	......	......	......	305
......	......	306^{2}	......	......	......	......	306	306	......	306^{4}
......	......	......	......	......	......	......	307	......	......	307
......	......	......	......	......	......	......	......	311	......	311
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THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society."

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA.

VOLUME XIV

PART 3

SESSION OF 1916-1917

HALIFAX

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TRANSACTIONS

OF THE

Nova Scotian Institute of Science

SESSION OF 1916-1917.

(Vol. XIV Part 3)

A New Evening Primrose. *Oenothera Novae-Scotiae.*

—By Reginald Ruggles Gates, Ph. D., F. L. S., sometime Lecturer in Biology and Cytology in the University of London, and Acting Associate Professor ot Zoology in the University of California.

(Read 13 November 1916)

The number of species of Oenothera was, until recently, supposed to be very limited. Although pre-Linnaean botanists described briefly a number of forms which they grew in their gardens, introduced from North America, yet Linnaeus recognized at first only one species, which he afterwards called *Oe. biennis.* He later described several other species, but the name *Oe. biennis* came to be applied generally to nearly all the forms in Eastern North America, and to those which had been naturalized in Europe as well.

The investigations of de Vries on mutation in *Oe. Lamarckiana* aroused new interest in the genus, and in recent years an intensive study of the group has produced a voluminous literature and has led incidentally to the recognition of a large number of forms which formerly passed under the name

Oe. biennis[1]. It is certain that a great many more clearly-defined species remain to be described from the North American continent. But the characters of these plants are so numerous and they are so often imperfectly expressed in the wild condition, that adequate studies and descriptions can only be made from the plants by cultivating them, in which condition their characters are fully expressed. Many studies of this kind are now being made, with the result that our knowledge of the genus Oenothera, the distribution, variability and characters of the species, is rapidly becoming more accurate and detailed.

The majority of the forms occupying the middle and eastern part of the continent agree with *Oe. biennis L.* in having petals about 20-25 mm. in length, though forms with larger and smaller flowers also occur. North of this area, in a zone extending in a general sense from Maine and Nova Scotia to Manitoba and passing through northern Ontario, occur forms having smaller flowers. Certain of these forms, related to *Oe. muricata L.*, have been briefly characterized elsewhere.[2] Here I wish to describe a species from Nova Scotia having small flowers as in *Oe. muricata* but clearly requiring delimitation as a distinct form. The description is as follows:

Oenothera Novae-Scotiae sp. nov.

Diameter of mature rosette (maximum) 48 cm., leaves smooth or slightly crinkled, elliptical or oblanceolate to nearly spatulate, relatively broad and rather broad pointed, about 25 cm. long and 56 mm. greatest width, margin obscurely repand-denticulate, narrowed below to petiole, midrib usually pink above and more or less pink beneath, leaf finely puberulent on both faces (Fig. 1).

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1 For a resumé of these forms and their taxonomic history, see Gates, The Mutation Factor in Evolution, with particular reference to Oenothera, chap. ii. MacMillan, 1915.

2 Op. cit., pp. 23-26.

Fig 1. Rosette of *Oenothera Novae-Scotiae*.

Fig 2. *Oenothera Novae-Scotiae* in bloom.

Mature plant (Fig. 2) about 3 ft. high, branching from near the base or from higher up, lower branches with a collar at their base, stem and branches reddish (usually bright red) to near the top, also bearing numerous long hairs arising from red papillæ. Stem-leaves about 15 cm. long and 35-40 mm. broad, finely puberulent, tapering at both ends, short-petioled, broad margin repand-denticulate, midribs pink above, and also below except near the base. Bracts more or less curled, very short petioled, lanceolate with rounded base and acute, narrow point.

Flowers small, buds green, cone 15 mm. long, squarish, sepal tips terminal, approximate, spreading at the extreme ends, petals 15 x 15 mm. (minimum length of petals at end of season 8 mm.), hypanthium 40 mm. long, 2.5 mm. thick, ovary 16 mm. long, bud cone and hypanthium bearing very scattered long hairs and numerous short ones; ovary reddish and with numerous rather small hairs of the longer type arising from red papillæ. Petals obcordate to truncate, lemon yellow, opening out flat and half-closing to a vertical position next day, not overlapping but with spaces between the petals, style short, surrounded by the anthers, stigma lobes stout, reaching 10 mm. in length: capsules green with scattered small red papillæ bearing hairs, cylindrical, tapering near the top, about 4 cm. long.

Diagnosis:

Folia radicalia plana aut leviter corrugata, elliptica, oblanceolata aut subspatulata, modice lata, circa 25 cm. longa et 56 mm. maxima latitudine margine repando-denticulato, utrinque subtiliter puberula, angustata ad petiolos, costis fere utrinque puniceis. Caulis et rami subrufi, multis longis pilis rubro-tuberculatis instructi. Folia caulina untrinque acuta, breviter petiolata, circa 15 cm. longa et 35-40 mm. lata, bracteæ plus aut minus crispæ. Spica densa. Petala flava, circa 15 mm. longa et 15 mm. lata; hypanthium 40 mm. longum: ovarium 16 mm. longum; antheræ stigmata attin-

gentes. Alabastræ rarissimis longis et multis brevis pilis instructæ, obsolete quadrangulares; apices sepalorum, terminales, approximati.

The main distinctive features of this segregate from *Oe. muricata* are (1) the broad, nearly smooth leaves of the rosette having relatively narrow, pale pink midribs, (2) the red stems with leaves tapering at both ends and bracts somewhat curled, (3) the green buds and small flowers.

The plants from which this species is described were grown at the University of California in 1916 from seeds collected on the North Mountain road above the reservoir near Middleton, Annapolis County, Nova Scotia, in September 1914. A type specimen is preserved in the Herbarium of the University of California, No. 193440.

As a part of my cultures in 1916, one thousand seeds of this species were germinated by placing them between blotters in a germinating incubator. The air in their seed coats had previously been replaced with water by putting the seeds in water under a bell jar and exhausting the air with an air-pump. In one month 836 of the seeds in the blotters had germinated, or 83.6%. Examination of the remaining seeds showed that 127 of them, or 12.7% of the whole number, were empty or contained quite small embryos. Thus almost complete germination was obtained. Of the seedlings which germinated, 424 were planted in soil in a greenhouse, and 370 of these were afterwards transplanted outdoors and grown to maturity. They were a very uniform lot, showing very little variability. A few, however, differed in having smaller rosettes with white midribs, and some of these produced dwarfed plants. It is probable that these dwarfed individuals received less water under the conditions of irrigation, and that they were therefore not genetic dwarfs. This point will be tested another year by growing their seeds. The only other variations noted were in width of leaves and in smoothness or slight crinkling of the leaves.

There is no evidence that the 12.7% of empty or nearly empty seeds represented a class of zygotes which was being eliminated, although it is possible this may have been so. The pollen was also examined at the end of the blooming season, and three flowers from as many different plants gave respectively 41.7%, 25.9% and 29.5% of bad pollen. Occasional 4-lobed grains (as in *Oe. gigas*) were also observed. Thus we find again a wild species producing a considerable amount of sterile pollen and non-viable seeds. Yet the flowers are close-pollinated and there is no reasonable basis for assuming this sterility to be the result of crossing.

The distribution of this species remains to be determined. It probably occurs widely in western Nova Scotia, but many species of Oenothera are found to be quite local in distribution. Another form in the *muricata* series, from Middleton, has been figured elsewhere[3].

In conclusion, the writer would be grateful for Oenothera seeds sent him from any part of Canada. Seeds should always be collected from individual plants separately, and should be accompanied by notes on the exact location and habitat. It is desirable to collect seeds separately from several individuals in a locality, to obtain a knowledge of the range of variation. By this means it will be possible ultimately to reach a thorough understanding of the variability and evolution of this remarkable genus from the systematic point of view.

A portion of the expenses of these cultures was defrayed by a grant from the Elizabeth Thompson Science Fund.

New York Botanical Garden.

[3] Op. cit., p. 23, figs. 4, 5.

The Phenology of Nova Scotia, 1916—By A. H. MacKay, LL.D.

(Read by title 14 May 1917)

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the school-room the flowering or other specimens when first observed, for authoritative determination by the teacher who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are compiled from 180 of the best schedules out of the 435 sent in. The selections were made and compiled under the direction of Mr. H. R. Shinner, B. A., and Miss M. G. McLeod, of the Education Department.

The schedules for each year are carefully bound up in a large annual volume which is placed in the Provincial Museum and Science Library where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated, are also bound in annual folio volumes for ease of consultation and preservation.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt, as below:—

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co's.	" " "
III.	Annapolis and Kings Counties,	(a) Coast, (b) North Mt., (c) Annapolis Valley, (d) Cornwallis Valley, (e) South Mt.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " "
VI.A.	Cobequid Slope (to the south),	" " "
VI.B.	Chignecto Slope (to the northwest),	" " "
VII.	Northumberland Straits Slope (to the n'h)	" " "
VIII.	Richmond & Cape Breton Co's.,	" " "
IX.	Bras d'Or Slope (to the southeast),	" " "
X.	Inverness Slope (to Gulf, N. W.),	" " "

The ten *regions* are indicated on the outline map on the next page.

THE LOCAL COMPILERS FOR EACH REGION, 1916.

Region No.		Region No.	
I.	Irma Campbell, Bay View, Dig. Co.	VIa.	Robt. Bagnell, Great Village, Col. Co.
II.	Seldon Bryson, Chester, Lun. Co.	VIb.	R. H. Wetmore, Parrsboro, Cum. Co.
III.	Merna Franke, Kentville, Kings Co.	VII.	Flora Zwicker, Tatamagouche, Col. Co.
IV.	Katherine Dawson, Maitland, Hants. Co.	VIII.	Mary B. MacDonald, L. Bras d'Or W., C. B
V.	G. Lawrence Leslie, Woodside, Hfx. Co.	IX. & X.	R. Stanley MacLeod, Wh. Pier, Sydney.

THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA

THE PHENOLOGY OF NOVA SCOTIA, 1916

[Compiled from the best 180 out of 435 local observation schedules.]

YEAR 1916.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

WHEN FIRST SEEN. — OBSERVATION REGIONS.

Year 1916	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum. & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv and Victoria; 10. Inverness Slope to Gulf	Average Dates
1 Alnus incana, Wild	132	116	113	113	110	117	118	127	110	117
2 Populus tremuloides	120	127	117	122	126	....	126	127	122	123
3 Epigea repens, L.	102	103	108	112	111	116	118	122	119	112
4 Equisetum arvense	120	125	121	134	133	126	128	138	131	127
5 Sanguinaria Canadensis	....	..	138	130	125	133	132	133	135	132
6 Viola blanda	123	124	128	127	130	123	129	133	130	127
7 Viola palmata, *cucuiata*	127	130	130	129	135	128	137	137	132	131
8 Hepatica triloba, etc.	....	133	116	....	155	....	114	140	....	131
9 Acer rubrum	123	130	126	129	131	133	133	141	129	131
10 Fragaria Virginiana	125	127	127	129	133	129	136	137	132	130
11 " fruit ripe	162	165	162	167	172	164	166	168	170	166
12 Taraxacum officinale	127	130	130	132	137	130	137	143	135	133
13 Erythronium Americanum	135	157	145	128	....	135	136			139
14 Coptis trifolia	129	131	133	134	138	136	137	141	140	135
15 Claytonia Caroliniana	126	126	156	131	132	132	133	140	137	135
16 Nepeta Glechoma	131	141	135	140	147	145	143	146	153	142

WHEN BECOMING COMMON. — OBSERVATION REGIONS.

Year 1916	Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum. & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8 Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria; 10. Inverness Slope to Gulf
1 Alnus incana, Wild	123	110	127	108	119	119	124	124	134	115
2 Populus tremuloides	128	126	133	121	125	129		130	133	131
3 Epigea repens, L.	121	111	120	117	118	120	125	125	129	127
4 Equisetum arvense	132	127	129	126	126	137	131	135	145	134
5 Sanguinaria Canadensis	137		.	144	134	144	135	139	138	128
6 Viola blanda	134	130	131	132	133	137	130	138	139	134
7 Viola palmata, *cucuiata*	137	134	136	135	136	111	137	138	143	137
8 Hepatica triloba, etc.	134	....	140	122	....	....	....	136	142	
9 Acer rubrum	136	129	137	132	136	137	135	138	146	137
10 Fragaria Virginiana	139	133	135	135	139	142	138	143	143	140
11 " fruit ripe	174	173	175	173	170	178	171	176	174	179
12 Taraxacum officinale	140	135	135	136	138	144	142	141	148	143
13 Erythronium Americanum	149	141	171	149	134	..	141	136		170
14 Coptis trifolia	142	136	137	137	138	145	143	145	147	146
15 Claytonia Caroliniana	143	149	130	160	140	140	143	136	150	142
16 Nepeta Glechoma	146	142	143	139	143	152	137	150	152	157

THE PHENOLOGY OF NOVA SCOTIA, 1916.—*Continued.*

YEAR 1916.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

WHEN FIRST SEEN. Observation Regions: 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S.Cum.&Col.)	7. N.Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria; 10. Inverness Slope to Gulf	Average Dates	No.	Year 1916	Average Dates	WHEN BECOMING COMMON. Observation Regions: 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cum & Col.)	7. N.Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria; 10. Inverness Slope to Gulf
139	140	138	142	148	140	146	152	152	149	17	Amelanchier Canadensis	149	147	146	144	148	153	143	151	151	157
....	182	....	....	....	....	....	....	....	182	18	" fruit ripe	186	....	186	....	....	....	....	....	....	....
139	149	146	149	153	145	151	153	156	149	19	Prunus Pennsylvanica	154	147	153	150	153	158	150	154	159	159
....	....	....	....	....	....	....	....	....	....	20	" fruit ripe	230	....	....	....	....	220	....	....	....	240
136	140	142	144	150	145	149	157	151	146	21	Vaccinium Can. and Penn.	152	145	145	149	150	146	146	155	162	165
....	193	....	184	231	....	220	....	....	207	22	" fruit ripe	217	....	194	....	213	235	....	225	....	....
149	152	152	149	161	152	158	160	162	155	23	Ranunculus acris	161	157	159	159	156	166	155	163	166	167
162	163	157	156	167	160	164	172	166	163	24	R. repens	168	167	167	162	161	171	165	169	177	171
146	150	142	146	153	146	151	150	158	149	25	Trill. erythrocarpum	155	153	154	149	158	159	150	158	155	158
141	146	148	147	153	150	154	158	162	151	26	Rhododendron Rhodora	156	150	152	153	153	158	156	159	163	164
150	152	148	153	154	150	154	157	154	152	27	Cornus Canadensis	157	159	158	152	159	156	153	158	162	161
....	172	147	166	....	....	165	152	....	160	28	" fruit ripe	169	....	179	150	162	....	....	196	157	....
150	151	153	151	158	146	151	157	161	153	29	Trientalis Americana	156	155	157	158	156	163	155	156	162	166
152	155	152	153	163	157	154	167	160	157	30	Clintonia borealis	162	158	161	157	159	168	159	160	170	167
157	157	157	152	169	....	155	159	164	159	31	Calla palustris	164	162	161	162	162	169	164	160	167	165
154	157	160	165	164	162	163	166	166	162	32	Cypripedium acaule	167	163	163	165	168	170	162	167	171	171
158	158	160	158	167	159	161	169	167	162	33	Sisyrinchium angustifolium	167	166	167	162	162	172	164	166	173	172
159	165	162	163	168	159	171	166	162	165	34	Linnæa borealis	170	167	172	168	167	174	165	175	170	172
156	162	156	154	159	152	166	160	169	159	35	Kalmia glauca	164	160	166	160	160	161	....	170	165	173
174	174	164	158	166	155	173	157	176	166	36	Kalmia augustifolia	172	180	179	169	160	171	163	177	162	182
175	164	162	166	174	165	161	172	....	167	37	Cratægus oxyacantha	170	....	172	168	166	....	172	166	178	....
158	165	158	166	166	159	161	177	165	163	38	Cratægus coccinea, etc.	169	165	172	162	170	174	164	166	180	167
164	164	165	167	172	165	169	169	162	167	39	Iris versicolor	172	170	171	170	171	176	166	173	176	176
163	166	163	164	171	162	165	172	179	166	40	Chrysanthemum Leucanthemum	175	172	173	169	171	175	165	175	197	178
170	169	171	168	165	170	164	174	174	169	41	Nuphar advena	175	177	174	175	173	172	179	168	179	178

160	158	162	162	163	160	159	162	159	161	42 Rubus strigosus	167	167	167	168	166	166	167	167	168	169
171	....	....	136	218	....	....	....	....	208	43 " fruit ripe	208	180		...	...	222	....	216	..	..
165	166	171	177	175	176	170	....	178	172	44 Rhinanthus Crista-galli	175	170	165	175	178	181		174		181
170	173	170	169	167	165	157	149	162	165	45 Rubus villosus	170	175	179	175	175	176	166	164	154	179
243	....	146	242	236	....	246	246	....	226	46 " fruit ripe	241	...	...	200	248	249	....	259	248	
166	167	....	172	176	....	173	172	175	171	47 Sarracenia purpurea	176	173	173		177	179	..	174	176	180
....	174	167	174	171	....	176	...	178	173	48 Brunella vulgaris	180	177	18[illegible]	180	178	178	...	178		187
175	176	172	176	....	171	173	....	172	174	49 Rosa lucida	180	180	182	178	181	...	175	177	....	186
165	169	168	170	172	170	171	171	176	170	50 Leontodon autumnale	171	173	174	172	176	175	175	176	175	181
169	167	139	165	....	....	170	168	172	164	51 Linaria vulgaris	170	179	169	146	172			175	171	178
125	135	138	138	142	137	139	144	141	132	52 Trees appear green	137	143	149	173	147	152	147	150	152	149
148	146	142	146	152	147	151	156	155	149	53 Ribes rubrum cultivated	154	155	152	158	150	157	148	156	162	159
....	....	....	206	....	....	....	....	....	206	54 " fruit ripe	216	....	...	..	216	.	....	.	.	...
160	147	146	154	155	149	153	157	160	153	55 R. nigrum cultivated	159	172	153	151	159	160	149	158	162	164
....	202	....	214	....	....	....	....	....	208	56 " fruit ripe	226	..	...	.	226	..		.	..	.
145	150	144	151	159	153	152	158	160	154	57 Prunus Cerasus	157	152	155	149	155	160	157	158	163	167
....	....	157	186	....	....	...	160	....	165	58 " fruit ripe	177	...	....	...	188	.	....	..	166	...
151	153	148	154	161	155	156	165	163	156	59 Prunus domestica	161	158	160	153	157	168	159	161	170	166
149	150	148	153	162	155	157	162	160	155	60 Pyrus Malus	161	157	153	156	152	167	160	163	168	167
160	163	160	159	169	159	164	170	168	163	61 Syringa vulgaris	169	169	169	164	164	174	162	169	175	172
161	165	160	165	167	156	162	169	163	163	62 Trifolium repens	168	17[illegible]	170	166	169	171	164	169	174	165
150	155	155	165	161	161	162	171	163	160	63 Trifolium pratense	166	164	162	162	167	166	162	169	177	167
160	158	160	163	166	158	167	166	....	162	64 Phleum pratense	168	170	166	166	171	169	159	172	172	
182	180	176	....	182	...	180	....	....	180	65 Solanum tuberosum	180	...	.	....	180	....	....	...	..	...
108	116	118	122	123	114	127	127	123	117	66 Ploughing (first of season)	130	119	124	128	128	130	124	135	134	152
125	121	133	131	132	127	136	140	129	130	67 Sowing	137	133	13[illegible]	139	138	139	126	143	145	135
119	121	134	132	131	131	133	130	128	129	68 Potato-planting	136	126	131	143	140	139	131	143	139	136
128	115	133	141	137	129	129	126	124	129	69 Sheep-shearing	138	139	124	145	145	145	136	143	142	133
188	..	191	218	207	...	217	217	...	206	70 Hay-cutting	216	....		...	218	200	...	218	228	....
....	233	250	244	235	242	245	255	256	245	71 Grain-cutting	252	...	...	255	249	251	248	247	264	...
27	151	166	268	273	283	278	278	272	250	72 Potato-digging	253	278	151	270	272	278	278	283	281	286
9	87	92	99	96	96	94	95	94	91	73aOpening of rivers										
98	101	018	105	106	.	108	012	102	104	73bOpening of lakes										
101	110	216	110	109	102	118	111	121	112	74aLast snow to whiten ground										
106	121	109	103	126	110	121	119	130	116	74b " fly in air										
112	124	127	124	123	..	133	144	121	122	75aLast spring frost—hard										
142	138	167	144	156	....	166	127	141	147	75b " —hoar										
89	92	109	96	94		90	112	....	97	76aWater in streams—high										
..	191	....	....	300	....	280	146	....	229	76b " —low										
289	165	239	159	248	249	263	280		249	77aFirst autumn frost—hoar										
322	300	268	285	280	282	282	292	287	289	77b " —hard										
317	310	303	279	295	301	287	281	284	295	78aFirst snow to fly in air										
317	318	310	327	305	316	313	315	286	312	78b " whiten ground										
..		320	280	321	284	239	50	....	267	79aClosing of lakes										
....	....	....	290	322	310	....	....	....	307	79b " rivers										
93	91	99	91	99	92	92	105	85	94	81aWild ducks migrating, N										
..	363	31	322	274	268	209	306	356	305	81b " S										
94	93	168	87	91	93	92	103	92	91	82aWild geese migrating N										

THE PHENOLOGY OF NOVA SCOTIA, 1916.—*Continued.*

Year 1916.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

When First Seen. Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cumb & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv. and Victoria / 10. Inverness Slope to Gulf	Average Dates	Year 1916.		When Becoming Common. Average Dates	Observation Regions. 1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and South Colchester	5. Halifax and Guysboro	6. S. Cobequid Slope, (S. Cumb. & Col.)	7. N. Cumb, Col, Pictou and Antigonish	8. Richmond and Cape Breton	9. Bras d'Or Slope, Inv and Victoria / 10. Inverness Slope to Gulf
114	361	341	261	319	317	.	294	300	288	82b Wild geese migrating	S.	....	....	....	....	....	....	....	....	....	....
91	92	92	91	99	98	96	103	95	95	83 Melospiza fasciata	North	....	....	....	....	....	....	....	....	....	....
90	91	92	91	90	90	93	94	93	91	84 Turdus migratorius	"	....	....	....	....	....	....	....	....	....	....
87	95	95	91	96	112	98	74	121	96	85 Junco hiemalis	"	....	....	....	....	....	....	....	....	....	....
100	92	127	118	133	130	127	151	118	121	86 Actitis macularia	"	....	....	....	....	....	....	....	....	....	....
129	142	130			154	126	152	....	137	87 Sturnella magna	"	....	....	....	....	....	....	....	....	....	....
128	130	124	128	122	133	125	128	128	127	88 Ceryle Alcyon	"	....	....	....	....	....	....	....	....	....	....
139	125	136	125	92	....	118	139	132	126	89 Dendrœca coronata	"	....	....	....	....	....	....	....	....	....	....
138	128	141	131	133	117	139	134	145	134	90 D. æstiva	"	....	....	....	....	....	....	....	....	....	....
141	111	121	128	128	90	115	125	126	121	91 Zonotrichia alba	"	....	....	....	....	....	....	....	....	....	....
149	148	148	148	153	148	151	160	156	151	92 Trochilus colubris	"	....	....	....	....	....	....	....	....	....	....
150	....	135	138	....	123	139	149	....	139	93 Tyrannus Carolinensis	"	....	....	....	....	....	....	....	....	....	....
....	133	135	111	159	115	128	155	142	135	94 Dolychonyx oryzivorus	"	....	....	....	....	....	....	....	....	....	....
152	150	138	142	149	110	140	150	....	141	95 Spinis tristis	"	....	....	....	....	....	....	....	....	....	....
140	146		167	129	128	145	142	129	141	96 Setophaga ruticilla	"	....	....	....	....	....	....	....	....	....	....
....	159	.	95		161	143	175	135	145	97 Ampelis cedrorum	"	....	....	....	....	....	....	....	....	....	....
123	134	142	136	129	127	143	128	141	134	98 Chordeiles Virginianus	"	....	....	....	....	....	....	....	....	....	....
104	107	108	110	115	112	113	118	112	111	99 First piping of frogs		....	....	....	....	....	....	....	....	....	....
114	107	116	118	117	130	125	127	114	116	100 First appearance, snakes		....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1916.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton	9. Bras d'Or Slope (Inv. & Victoria)	10. Inverness Slope to Gulf.	Total Year 1916.
......	......	......	......	......	......	......	39	......	......	39
......	......	......	......	50	......	......	......	......	......	50
......	......	......	......	57^{3}	......	57^{3}	57^{2}	......	......	57^{8}
......	......	......	......	58	......	58^{4}	58^{4}	......	......	58^{9}
......	......	......	......	......	......	59^{7}	......	......	......	59^{7}
......	......	......	86	......	......	......	......	......	......	86
......	......	......	......	95	......	......	......	......	......	95
......	97	......	......	......	......	......	......	......	......	97
......	......	......	......	......	......	......	......	......	98	98
......	......	......	......	99	......	......	99	......	......	99^{2}
......	......	......	......	100^{2}	......	100^{11}	100^{6}	......	......	100^{19}
......	......	......	......	102	......	......	......	......	......	102
......	......	......	......	......	......	......	......	......	103	103
......	......	......	......	......	......	......	107	......	......	107
......	111	......	......	......	......	......	......	......	111	111^{2}
......	112^{4}	......	......	......	......	......	......	......	......	112^{4}
......	113	......	......	......	......	......	......	......	......	113
118	......	......	......	......	......	......	......	......	......	118
119^{7}	......	......	......	......	......	......	......	......	......	119^{7}
......	......	......	123	......	......	......	......	......	......	123
......	128	......	......	......	......	128	......	......	......	128^{2}
......	129^{2}	129	129	......	......	......	......	......	......	129^{4}
......	......	......	......	130	......	......	......	......	......	130
......	......	......	......	131^{2}	......	......	131^{2}	......	131^{2}	131^{6}
......	......	......	......	......	......	......	132^{3}	......	......	132^{3}
......	......	......	......	......	......	......	......	......	133	133
138	......	......	......	......	......	......	......	......	......	138
139	......	......	......	......	......	......	......	......	......	139
......	......	......	......	......	......	140^{2}	......	......	......	140^{2}
......	......	......	......	141	......	......	......	......	......	141
......	......	......	......	143	......	......	......	......	......	143
146^{2}	......	......	......	......	......	......	......	......	......	146^{2}
147^{4}	147^{11}	......	......	147	......	......	......	......	......	147^{16}
......	......	......	......	148	......	......	......	......	......	148
......	......	......	......	149	......	......	......	......	......	149
......	......	......	......	151	......	......	......	......	......	151
......	......	......	......	......	155	......	......	......	......	155
......	......	......	......	156	......	......	......	......	......	156

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1916.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. and Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton	9. Bras d'Or Slope (Inv. & Victoria).	10. Inverness Slope to Gulf.	Total Year 1916.
......	......	......	......	160	......	......	......	......	......	160
......	......	......	......	161	......	......	......	......	......	161
......	162	......	......	......	......	......	......	......	......	162
......	163^{2}	......	......	163	......	......	......	......	......	163^{3}
......	......	......	164^{3}	164^{7}	164	164^{30}	164^{3}	......	164	164^{45}
......	......	......	......	165^{2}	......	......	......	......	......	165^{2}
171^{3}	171^{2}	171	171	171^{2}	171	......	171	......	......	171^{11}
172^{8}	172^{11}	172^{4}	172^{3}	172^{4}	172^{3}	172^{8}	172^{6}	......	172^{2}	172^{49}
......	......	......	......	......	......	173	173	......	......	173^{2}
......	174	......	......	174	......	......	......	......	......	174^{2}
......	......	......	......	175	......	......	......	......	......	175
......	......	......	......	......	......	......	......	......	179	179
180^{3}	180^{2}	180^{2}	180^{3}	......	180	180^{8}	......	......	180^{2}	180^{21}
181^{4}	181^{5}	......	......	......	......	......	......	......	......	181^{9}
182	......	182	......	......	......	......	......	......	......	182^{2}
......	......	......	228	......	......	......	......	......	......	228
......	......	......	237	......	......	......	......	......	......	237
......	......	......	......	......	......	......	251	......	......	251
......	252	......	......	......	......	......	252	......	......	252^{2}
......	......	......	......	253	......	......	......	......	......	253
......	......	......	258	......	......	......	......	......	......	258
......	......	......	260	......	......	......	......	......	......	260
......	......	......	......	......	......	......	261	......	......	261
262	......	......	......	......	......	......	......	......	......	262
......	......	266	......	......	......	266	......	......	......	266^{2}
......	267	......	......	......	......	......	......	......	......	267
......	......	......	......	269	......	......	......	......	......	269
......	......	282	282^{2}	......	......	......	......	......	......	282^{3}
......	......	......	......	283^{2}	......	......	......	......	......	283^{2}
......	......	......	......	301	......	......	......	......	......	301
......	......	......	303	......	......	......	......	......	......	303
......	......	......	......	......	......	306	......	......	......	306
307	307	307	307	307	......	......	......	......	......	307^{5}
......	......	308	......	308^{3}	......	......	......	......	......	308^{4}
......	......	......	......	315	315	......	315^{2}	......	......	315^{4}
......	......	......	......	......	......	......	......	......	316	316
......	......	......	......	......	318	......	......	......	......	318
......	......	......	......	......	321	......	......	......	......	321
340	......	......	......	......	......	......	340	......	......	340^{2}
......	......	......	......	359	......	......	......	......	......	359

Notes on the Birds of the Grand Pré Region, Kings County, Nova Scotia.— By Robie Wilfrid Tufts, Wolfville, N. S.

(Read 14 May 1917)

The observations herein recorded are the fruits of careful and painstaking field-work, carried on intermittently for a period covering the past twenty years.

The country covered by these notes is the region embraced by Kings County, especially that portion within a radius of ten miles of Wolfville, and including the Grand Pré (or Great Prairie) which stretches from the mouth of the Cornwallis River to the mouth of the Gaspereau. The mud-flats exposed at low tide in Minas Basin; the salt marshes and sand beaches adjacent to the Grand Pré meadows; the heavily wooded hills, fresh-water lakes, river marges and forests of the Black River (a tributary of the Gaspereau River); all these have contributed their quota to the observations here set down.

It may be noted that my spring records for that class of birds known as "waders" are rather vague and incomplete. This must not be construed as indicating that these birds do not pass through this region on their northern journey, but rather that my time at this season of the year is always spent in the more attractive woodland areas.

To my brother, Dr. Harold Freeman Tufts, now of Boston, Mass., I am deeply indebted for much general data, more particularly in reference to the "water birds".

The list contains 180 species and subspecies, and of these we have discovered the nests or seen the fledgings of 91. The numbers and nomenclature are those of the American Ornithologists' Union. Local bird names in use in the district are enclosed in quotation marks.

The following, I believe, is a complete list of all articles that have appeared in reference to the birds of this particular district.

"Notes on the Birds of King's County, Nova Scotia." By Harold [Freeman] Tufts. The Ottawa Naturalist, vol. 12, no. 9 (Dec., 1898), pp. 172-177; no. 11 (Feb., 1899), pp. 229-233; no. 12 (Mar., 1899), pp. 259-262. An annotated list of 158 nominal species.

"Nesting of Crossbills in Nova Scotia." By Harold F. Tufts. The Auk, N. Y., vol. 23, July, 1906, pp. 339-340. Notes on the nesting of American and White-winged Crossbills near Wolfville, in the winter of 1906.

"A New Song Sparrow from Nova Scotia." By John E. Thayer and Outram Bangs. Proceedings of New England Zoological Club, vol. 5, pp. 67-68, May 29, 1914. Description of *Melospiza melodia acadica* subsp. nov., collected by R. W. Tufts at Wolfville.

"Wilson's Snipe Wintering in Nova Scotia." By R. W. Tufts. Bird-Lore, Harrisburg, Pa., vol. 17, no. 3 (May-June, 1915), p. 208. Describes occurrence of a snipe at Wolfville in January, 1915.

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2. *Colymbus holbœllii* (Reinh.). Holbœll's Grebe.—On May 13, 1917, I saw one of these birds on Sunken Lake in the Black River district. It was near the shore and was readily distinguished from *auritus* and *podiceps* by its much larger size. I have a record of this species from Lunenburg County, but this is the first for Kings.

3. *Colymbus auritus* Linn. Horned Grebe.—Rare transient. Only one record; a specimen in immature plumage taken in December, 1890, by D. R. Munro, of Wolfville, near the mouth of the Gaspereau River. This bird was mounted and is still preserved.

6. *Podilymbus podiceps* (Linn.). PIED-BILLED GREBE.—Uncommon transient. A few records for late summer and fall. A male taken Aug. 30th, 1900, by myself in a small fresh-water pond near Wolfville.

7. *Gavia immer* (Brünn.). LOON.—Summer resident. Common about our lakes and still-waters, also occasionally observed along the coast in late November. Their arrival at the lakes in spring is coincident with the breaking up of the ice; and they remain till driven out by its return. Nests in June on low-lying islands, always within a few feet from the water's edge. Eggs two in number.

11. *Gavia stellata* (Pont.). RED-THROATED LOON.—Rare spring, fall, and winter visitor. A specimen in immature plumage taken Nov. 8th, 1913, by the writer, at the mouth of the Cornwallis; and a female on May 26, 1917 in the same locality. No observations except at salt-water.

34. *Alle alle* (Linn.). DOVEKIE.—One record only. A specimen taken November, 1900, by myself, on the Grand Pré, in a pond hole a few hundred yards from tide water. A fierce gale was raging, and the bird, nearly exhausted, was easily captured alive.

47. *Larus marinus* Linn. GREAT BLACK-BACKED GULL; "SADDLE-BACK".— Permanent resident. Common in summer, rare and irregular in winter. During the latter part of April the "Black-backs" may be seen in twos and threes, winging their way inland from the salt marshes of the Minas Basin to the fresh-water lakes, several of which are favored by these birds as breeding localities. One of these, Methaul's Lake, I visited in 1908 and again in 1914, about the middle of May. About 20 to 30

pairs were found nesting on each occasion. Solitary granite boulders in the middle of the lake were used, some being scarcely large enough to hold the nest. Some small islands contained four or five nests. The birds were very shy, and left their nests while the intruder was still several hundred yards distant. Eggs three in number.

51. *Larus argentatus* Pont. HERRING GULL; "SEA GULL", "GRAY GULL."—Permanent resident; very common in summer, rare and irregular in midwinter. Nests about June 1st. A favorite breeding site is Isle-au-Haute, an abrupt rock-bound island of the Bay of Fundy.

54. *Larus delawarensis* Ord. RING-BILLED GULL.—One record only. Specimen taken in May, 1896, by H. F. Tufts.

60. *Larus philadelphia* (Ord.). BONAPARTE'S GULL.—Rare transient. One record only. Specimen t ken Sept. 28, 1897, on the Grand Pré, by H. F. Tufts. A heavy north-east rain storm and a high tide prevailed at the time.

106. *Oceanodroma leucorhoa* (Vieill.). LEACH'S PETREL; "MOTHER CAREY'S CHICKEN."—Exceedingly rare. One observation only. After a heavy storm, on Nov. 8, 1913, a flock of a dozen or more were seen at the mouth of the Cornwallis. These were asleep, holding on to the stems of the rank marsh sedges which were about half submerged by the high tide, and thus afforded a mooring. We approached them in a boat, and captured several in our hands.

117. *Sula brassana* (Linn.). GANNET.—About 1898 and regularly for some years previous, a pair of Gannets nested at Harborville, Kings County. The nest was on a ledge of rock, about one hundred

feet above the beach, on the perpendicular sea-wall of the Bay of Fundy. Above the ledge was a huge overhang of rock extending thirty or forty feet out and rendering the ledge absolutely inaccessible. One of the pair, probably the female, was shot while on or by the nest by a young man named Morris, and was picked up on the beach below. Charles Morris, now of Margaretville, Annapolis County, the boy's father, recently told me of this, and described the bird so clearly as to leave no doubt whatever as to its identity, although the specimen was not preserved. This is the only record I have of the occurrence of this species in Kings County.

119. *Phalacrocorax carbo* (Linn.). CORMORANT.—Uncommon transient. One specimen taken in November, 1898, near the mouth of the Gaspereau River. Occasionally seen on the Minas Basin in spring and fall, but more frequently in the spring.

120. *Phalacrocorax auritus auritus* (Swains.). DOUBLE-CRESTED CORMORANT.—A fine specimen was captured alive in a fish-weir on the mud-flats off Starr's Point, Cornwallis, on May 16, 1917, and a second specimen was taken in the same weir on May 28th of the same year. They are the only records I have.

129. *Mergus americanus* (Cass.). AMERICAN MERGANSER; "GOOSANDER."—Uncommon winter visitor. Only a few records. A specimen in immature plumage taken on the Grand Pré marshes, Dec. 9, 1913. A male in full plumage taken in December, 1898. No observations except at salt water.

130. *Mergus serrator* (Linn.). RED-BREASTED MERGANSER; "SHELL-DRAKE."—Permanent resident, most common about our rivers and lakes. Breeds about the middle of May. Locally this bird is frequently mistaken for the rare Wood Duck.

132. *Anas platyrhynchos* Linn. MALLARD.—Rare fall visitor Two records only. A fine drake taken on the Grand Pré, Oct. 1900, by D. R. Munro, of Wolfville, and a specimen in female or immature plumage by H. A. Ford, now of Calgary, Alta., also on the Grand Pré, in Oct. 1903.

133. *Anas rubripes* Brewst. BLACK DUCK; BLUE-WINGED DUCK.—Abundant permanent resident. These birds frequent the salt marshes about the estuaries of the Minas Basin from September to April. With the advent of spring and the breeding instinct, they leave for the inland fresh-water lakes and rivers. Some remain to breed in the fresh-water sloughs, pond-holes and ditches of the Grand Pré. Late in November and all through December when the ice has driven the inland breeding ducks to the coast, flocks of thousands may be seen any day, feeding on the salt marsh—known locally as "The Flats"—at the mouth of the Cornwallis River. During January and February fully ninety per cent. of these birds leave for more southerly feeding grounds.

137. *Mareca americana* (Gmel.). BALDPATE.—Rare fall migrant. One specimen taken by my brother, H. F. Tufts, on the Grand Pré, in October, 1896.

139. *Nettion carolinense* (Gmel.). GREEN-WINGED TEAL.—Fall migrant, not so common as formerly. Two records for winter. A male taken by H. F. Tufts, Jan. 11, 1898, and two specimens seen at mouth of Gaspereau, Jan. 3, 1916.

140. *Querquedula discors* (Linn.). BLUE-WINGED TEAL.—Rare fall migrant. One record only,— a specimen in immature plumage, taken by my brother, Sept. 27, 1898.

143. *Dafila acuta* (Linn.). PINTAIL.—Uncommon fall migrant. A few specimens, which I have seen in the flesh, have been taken by local gunners during the period covered by these notes,

149. *Marila affinis* (Eyt.). LESSER SCAUP DUCK.—Rare fall migrant. Two specimens taken by H. F. Tufts on the Grand Pré dykes, one in the fall of 1896, and the other on Oct. 14, 1902.

153. *Charitonetta albeola* (Linn.). BUFFLEHEAD.—Rare fall migrant. One specimen shot by my brother on Minas Basin in October 1896, after a heavy storm.

154. *Harilda hyemalis* (Linn.). OLD SQUAW; "PINE KNOT;" "COCKAWEE."—Common along the coast of the Bay of Fundy. Occasionally observed in small flocks in the late fall in Minas Basin.

160. *Somateria dresseri* Sharpe. AMERICAN EIDER.—Rare fall visitant. In November, about 1898, a large flock of Eiders was regularly seen on "The Flats" at the mouth of the Cornwallis River. Nov. 1st to 10th, 1903, a flock of fifty or more was regularly observed in the same vicinity.

163. *Oidemia americana* Swains. AMERICAN SCOTER; "COOT."—Uncommon and irregular. Sometimes a large flock is seen in Minas Basin in the fall after a heavy storm.

165. *Oidemia deglandi* Bonap. WHITE-WINGED SCOTER.—Much more common than the preceding species. Seen from April to November in Minas Basin. Some years ago, when the shad fishing industry flourished, these birds, during the moulting season, would become stranded on the mud-flats behind the the seines, and being unable to fly were easily captured.

166. *Oidemia perspicillata* (Linn.). SURF SCOTER.—A male of this species, in transition plumage (no white crown patch, otherwise typical) was taken on the mud-flats at Starr's Point, Cornwallis, May 21st, 1917, and brought to me alive. Though unhurt, it was not able to rise and seemed to be starving in the midst of plenty. The following day a female was taken about the same place and was in a similar emaciated condition. Both were mounted and are now in the Provincial Museum at Halifax.

172. *Branta canadensis canadensis* (Linn.). CANADA GOOSE; "WILD GOOSE."—Common spring and fall migrant. While seen on the marshes as early as Feb. 21, ('97), the average date for spring arrivals is the latter part of March. Some seasons they linger on well into April, while other years they remain but a few days. About the middle of December, and almost any day thereafter until the end of that month, these living wedges may be seen by day or heard by night, "honking" high over head on apparently tireless wings. They rarely stop on our marshes in the fall.

173. *Branta bernicla glaucogastra* (Brehm). BRANT.—Rare spring and fall migrant. Sometimes seen in the late fall after a severe storm. In the spring of 1870, the year following the very extraordinary "Saxby tide" of Oct., 1869, I have been told that these birds were seen in unusually large numbers, and many specimens were taken. Since that time their occurrence has been rare and irregular, and I have no records since the spring (April) of 1903.

190. *Botaurus lentiginosus* (Montag.). AMERICAN BITTERN; "STAKE DRIVER;" "MARSH HEN."—Fairly common

summer resident. Common on the Grand Pré in fall from middle of August to middle of October. Nests in May. Any sluggish stream or pond hole with reedy margin is a likely place to find these strange looking birds.

194. *Ardea herodias herodias* Linn. GREAT BLUE HERON; "CRANE."—Summer resident, occurring from about April 10 to latter part of October. Most common during the fall, about the extensive mud flats which are bare at low tide—also commonly seen during the spring and summer about the inland fresh-water lakes and streams. On May 22nd, 1913, I had the rather rare privilege of visiting a heron colony in the Cloud Lake region near the Kings-Annapolis line. Securing information from a trapper as to the approximate location of this colony, I started with a guide through heavily wooded country. Our objective was a ridge of land, ten miles distant, which separated two small lakes. Arrived there, we found it covered with a magnificent growth of giant, shaggy trunked, yellow birches. After much ranging back and forth we reached the vicinity of the nests, and soon the birds, attracted by the noise we made, were flying overhead uttering their raucous cries. A few minutes later we found ourselves in the midst of the heronry—and a noisy place it was. A few big spruces and hemlocks were interspersed among the birches, and the top of each one served as a perch for an old heron, which by the aid of toes and flapping wings, was able to hold on after a fashion. Over 50 nests could be seen, but of these only about 20 were new. Two trees contained three nests; several had two, but in most cases there was but one nest to a tree. They were fastened among the topmost twigs,

at heights ranging from 70 to 85 feet. Many nests contained young birds—their cries could be heard plainly, and in some cases their long necks protruded over the edge of the nest. Under such nests we invariably found bits of broken blue egg-shells. Finally a nest was located under which no shells could be found, but other tell-tale signs showed that it was in use. The first limbs were fully forty feet up, and by this time a fierce gale was blowing, accompanied by driving rain; but after a strenuous climb I gained the topmost twigs which held the nest. It consisted of a rude platform of twigs, and had a rough lining of reeds and shredded bark. It contained 5 eggs, pale blue in color. Some eight or ten years ago, from 75 to 100 pairs were numbered in this colony. The diminution in numbers has been caused chiefly, I believe, by the wanton persecution that these birds receive at the hands of ignorant hunters and trappers, who blaze away with their rifles at the perching birds which make easy and inviting targets. About a dozen remains of adult birds were found under the trees we visited.

202. *Nycticorax nycticorax naevius* (Bodd.). Black Crowned Night Heron.—Rare transient visitor. One record only, a specimen in immature plumage taken on the Grand Pré, Oct. 22nd 1898.

214. *Porzana carolina* (Linn.). Sora.—Summer resident. Probably not uncommon, but seldom seen on account of its retiring habits. Frequents reed-grown sloughs, pond holes and cat-tail swamps of the Grand Pré. When seen is usually walking or running over the reedy surface of the water from one tangle of rushes to the next.

215. *Coturnicops noveboracensis* (Gmel.). YELLOW RAIL.—One record only. Sept. 19, 1895, a specimen was taken alive by my brother near the mouth of the Cornwallis River. It seemed unable to rise and tried to hide in the grass, but apparently had not been wounded.

219. *Gallinula galeata galeata* (Licht.). FLORIDA GALLINULE.—Rare; two records only, both at Canard River, a sluggish reed-grown stream which winds through the meadows and flows into Minas Basin. One taken Sept. 26, 1898, by my brother, and the other one, Oct. 15, 1913, brought to me in the flesh for identification.

222. *Phalaropus fulicarius* (Linn.). RED PHALAROPE.—Only one record, a specimen taken on the Grand Pré (H. F. Tufts), Oct. 17, 1898, after a north-easterly storm.

228. *Philohela minor* (Gmel.). AMERICAN WOODCOCK.—Summer resident; not uncommon in suitable localities from first week in April to November 10th, or until the advent of frost compels them to forsake their feeding grounds. Most common during October, the period of southern migration. They nest early in May, on the ground; and any fine evening (or at daybreak) during the nesting period the male may be heard singing his weird song which accompanies his aerial performance known as the "sky dance," so admirably described by Chapman in his "Birds of Eastern North America". The female sits so "close" on her eggs that she may often be touched before being induced to leave them.

230. *Gallinago delicata* (Ord.). WILSON'S SNIPE; "MEADOW HEN;" "ENGLISH SNIPE;" "JACK SNIPE."—Not uncommon summer resident in suitable localities,

but more common in the fall during the migration. Occurs from middle of April to late in November. In 1896 a pair wintered near Wolfville in a sheltered swamp, watered by a series of springs, which do not freeze even in the severest weather Again in 1915 (January, etc.) a single bird wintered in this same swamp, and was frequently observed (see Bird Lore, vol. 17, no. 3, May-June, 1915, p. 208). These birds are much less common than formerly.

232. *Macrorhamphus griseus scolopaceus* (Say). LONG-BILLED DOWITCHER.—I have but a single record of the occurrence of this bird. Oct. 20, 1898, my brother shot a specimen on the Grand Pré. It was feeding by a fresh-water pond hole a few rods from the salt marsh and was very tame.

234. *Tringa canutus* Linn. KNOT; "ROBIN SNIPE."—Uncommon and irregular transient visitor in autumn. Two specimens, a male and a female taken at Long Island Beach, Aug. 20, 1898 (H. F. Tufts). A female taken Aug. 27, 1907 (R. W. T.).

239. *Pisobia maculata* (Vieill.). PECTORAL SANDPIPER; "GRASS SNIPE."—Formerly a common fall visitor; but of late years uncommon and irregular. Found generally on the salt marshes after the hay has been cut.

240. *Pisobia fuscicollis* (Vieill.). WHITE-RUMPED SANDPIPER —Rather uncommon, but regular, fall visitor; Sept. 15 to November 25. Found at Long Island Beach.

241. *Pisobia bairdi* (Coues). BAIRD'S SANDPIPER.—Very rare fall visitant. One specimen taken by my brother, Sept. 7th, 1899, is the only record. His notes read:—"This bird was feeding with a half dozen or more Least Sandpipers and was readily

distinguished from them by its larger size and buff markings." This bird was mounted, and is now, I believe, in the Victoria Memorial Museum (Geological Survey) at Ottawa.

242. *Pisobia minutilla* (Vieill.). LEAST SANDPIPER; "PEEP." —Common in fall, rare in spring. Occurs from July 25 to Oct. 20th. Frequents salt marshes after hay is cut, the mud-flats at low tide, or the ponds of brackish water just out of reach of the tide, but is rarely seen on the sand beaches.

243a. *Pelidna alpina sakhalina* (Vieill.). RED-BACKED SANDPIPER.—Uncommon autumn visitor. Seen on Long Island Beach during latter part of August and first of September in pairs or small flocks.*

246. *Ereunetes pusillus* (Linn.). SEMIPALMATED SANDPIPER; "PEEP."—From about July 23rd to latter part of September these birds may be seen on the mud flats and sand beaches. They are by far the most common among the shore-birds which visit Nova Scotia during the fall migrations. At Long Island Beach, where most of my observations have been taken, they occur in myriads from August 5th to 20th. Here they are much persecuted by "pot-hunters," despite the fact that they are protected (?) by theProvincial game laws till Sept. 1st, by which date most of them have passed on.

248. *Calidris leucophœa* (Pall.). SANDERLING.—Common fall migrant, Sept. 1 to Nov 25th. One record for winter, a pair seen at mouth of Gaspereau River, Jan. 7th, 1916. No records for spring.

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*Compare also Piers's remarks on the possibility of the occurrence of the Dunlin (*Pelidna alpina alpina*) in Nova Scotia, in Trans. N. S. Inst. Sc., vol, 13, pp. 232-234 (1915).

251. *Limosa hæmastica* (Linn.). HUDSONIAN GODWIT.—Rare fall migrant. One record only, a specimen taken by my brother, Oct. 19, 1899, on the Grand Pré.

254. *Totanus melanoleucus* (Gmel.). GREATER YELLOW-LEGS.—Transient visitor in spring and autumn. Not so common as formerly. Occurs in spring, May 12 to 21st., in fall from Aug. 10 to Nov. 1. Seen chiefly about the Grand Pré marshes, though often to be noted about the shores of our inland lakes and rivers.

255. *Totanus flavipes* (Gmel.). LESSER YELLOW-LEGS.—Fall migrant, formerly not uncommon. No records since Aug. 13, 1898, when two were shot at Long Island (H. F. T.) This species was always less common than the "Greater," but during the past twenty years, seems to have become very rare. I have records for 1896, 1897, and 1898 all in August. Since 1898 my opportunities for observing it have been rather limited, but I am satisfied that it is much more uncommon than formerly.

256. *Helodromas solitarius solitarius* (Wils.). SOLITARY SANDPIPER.—Rather uncommon fall migrant, less common than formerly; July 20th to Oct. 1st. One record for spring, a belated, lone specimen seen along the Gaspereau River, May 24, 1913.

261. *Bartramia longicauda* (Bechst.). BARTRAMIAN SANDPIPER.—Rare and irregular fall visitor. Several of these birds were observed on the Grand Pré meadows by my brother, Sept. 13, 1896, one of which was taken. Another was taken by him on Canard dykes, Oct. 8, 1902, and is now in the Provincial Museum, Halifax. These are the only records I have.

263. *Actitis macularia* (Linn.). SPOTTED SANDPIPER; "TEETER-TAIL;" "PEEP."—Summer resident, common; nesting first week in June. Found about the rocky lake shores and river margins; also (chiefly after the nesting season) along the shores of tide water.

265. *Numenius hudsonicus* Lath. HUDSONIAN CURLEW.—Rare fall migrant. A flock of five was seen Sept. 1899, on the Grand Pré, three of which were taken (H. F. T.). I have no other records till 1906, when, on September 11th I saw three chasing grasshoppers on the Grand Pré meadows. A few other records, all for September.

270. *Squatarola squatarola* (Linn.). BLACK-BELLIED PLOVER; "BEETLE HEAD."—Not uncommon fall migrant. Seen from August 10th to Nov. 15 or later, chiefly about the sand beach at Long Island, and on the exposed mud flats; also found on the salt-marshes after the hay is gathered, or occasionally inside on the green meadows. The adult birds appear first in the autumn, and by Sept. 20th the immature plumaged birds come along. By this time, however, the former have passed on further south. The young birds with their whitish breasts are not infrequently mistaken for the now rare Golden Plover.

272. *Charadrius dominicus dominicus* (Müll.). GOLDEN PLOVER.—Formerly common transient in autumn; now rare and irregular. As recently as 1888 and 1890 Golden Plover occurred about Wolfville during September and October in large flocks and seemed to favor the upland pastures for their feeding ground. Since then I have records for Sept. 12, 1898, Sept. 19, 1899, Aug. 27, 1907, Sept. 20, 1908, —singles and small flocks, all seen on the Grand

Pré meadows and Long Island beach. The Golden Plover has no hind toe, and it is the total absence of this member which affords the chief distinguishing mark between this species and the Black-bellied Plover,—the immature plumaged birds of both species being very similar as to color and size.

274. *Ægialitis semipalmata* (Bonap.). SEMIPALMATED PLOVER; "RING-NECK."—Common fall migrant. From about July 25th to Sept. 10th these birds may be found at Long Island beach, feeding in small scattered flocks by themselves or mingled with the large flocks of Semi-palmated Sandpipers. I have no records for spring though I have no doubt as to their regular occurrence at that season.

283. *Arenaria interpres interpres* (Linn.). TURNSTONE.—Rare and irregular fall transient. A few specimens taken at Long Island beach, Aug. 20, 1898(1); Aug. 24, 1899(3); Aug. 27, 1907 (1); a few other records for August.

298c. *Canachites candensis canace* (Linn.). CANADA SPRUCE PARTRIDGE.—Rare permanent resident. Nests about the middle of May. This bird is most frequently found in the spruce swamps and extensive barrens of the interior and owing to its apparent stupidity and tameness is very easily taken. In the fall, about 1890, a female appeared in our garden and could be touched with the hand—it was so tame.*

300b. *Bonasa umbellus thayeri* Bangs. NOVA SCOTIAN RUFFED GROUSE; "BIRCH PARTRIDGE."—Common permanent resident. Nests about May 10th on the

*Some years ago Watson L. Bishop, while residing at Kentville, Kings Co., successfully kept a number of Spruce Partridges in a large enclosure for several years, as described in his paper on "The Canada Grouse in its Captivity, its food, habits, etc." in Trans. N. S. Inst. Sci., vol. 13, pp. 150-153 (1912).

ground, and lays from 9 to 12 eggs. Despite its persecution by the ubiquitous gunners, to say nothing of its winged and four-footed enemies, this splendid game bird seems to be holding its own in this locality.

315. *Ectopistes migratorius* (Linn.). PASSENGER PIGEON; "WILD PIGEON."—I have not been able to learn anything definite about the occurrence of this bird in Kings County years ago when the species frequented the province. The following information applies to New Albany, a small settlement in the adjoining county of Annapolis, ten miles south of Middleton and about eight miles westward of the Kings-Annapolis Counties line. Although not actually referring to Kings County it is worthy of preservation as the latest occurrence known to me of this extinct species in this locality. During the boyhood of my father, Prof. J. F. Tufts of Acadia University, who was born at New Albany in 1843, flocks of "wild pigeons" were not uncommon there, though they were not seen in large numbers. The last time he can recollect having seen one of these flocks was in the autumn of 1855, when twenty or more of the birds alighted on the limbs of a huge dead pine. They remained there for some moments until alarmed by a gunshot from the thick undergrowth beneath the tree. Three of the birds were seen to drop. My father ran over to the tree and found there an old Indian trapper with a wounded pigeon in each hand and the third lying dead beside him.

316. *Zenaidura macroura carolinensis* (Linn.).—MOURNING DOVE.—Rare and irregular; two records only. One taken on the Grand Pré, Oct. 1896 (H. F. T.),

and the other seen in midwinter (Jan. 1910) in the Gaspereau valley. The snow was deep and the bird was feeding on weed seeds in a sheltered nook. It was observed there for several days and when alarmed would always seek shelter in a nearby heavy growth of spruce.

331. *Circus hudsonius* (Linn.). MARSH HAWK; "TOAD HAWK;" "MOUSE HAWK."—Summer resident. Common on the Grand Pré meadows. Arrives first part of April and remains until latter part of October. One record for winter—a female seen on the Grand Pré, Jan. 1st (1917), and again on Feb. 25th of the same year. I have no doubt this was the same bird. Nests about May 15th.

332. *Accipiter velox* (Wils.). SHARP-SHINNED HAWK- "CHICKEN HAWK."—Permanent resident, fairly com; mon. In winter these birds, commonly called "Chicken Hawks," may sometimes be seen about the streets of the town, darting after English sparrows, and apparently quite fearless of the passers-by.

333. *Accipiter cooperi* (Bonap.). COOPER'S HAWK.—Uncommon. No records for the winter months. A nest found May 18th, 1904, built in a maple tree about 30 feet up, contained four eggs.

334. *Astur atricapillus actricapillus* (Wils.). AMERICAN GOSHAWK; "BLUE HEN HAWK;" "BLUE DARTER."—Uncommon permanent resident. These hawks frequent the heavily-wooded districts generally, but in fall they prefer the smaller woods adjacent to farms, especially those which are well stocked with poultry, on which they prey. They nest in hardwood forests, and return to the same nesting site year after year. The nest is generally placed in a

beech or maple, 15 to 30 feet from the ground. Some fifteen nests of this species have been observed. Eggs 2 to 4 (usually 3).

337. *Buteo borealis borealis* (Gmel.). RED-TAILED HAWK.—Summer resident, not uncommon. Occurs from March 20th to last of October. More common inland—a bird of the hills and big woods. Nests the last week of April in the Black River regions.

347a. *Archibuteo lagopus sancti-johannis* (Gmel.). AMERICAN ROUGH-LEGGED HAWK.—Rare winter visitant of irregular occurrence Common on the Grand Pré during the winter of 1899-1900, when it was not unusual to observe twenty-five or more in a single afternoon. None have been seen since.

352. *Haliæetus leucocephalus leucocephalus* (Linn.). BALD EAGLE.—Exceedingly rare. About 1895 a pair of eagles nested at Long Island, but this nest with the young was destroyed by farmers of that locality. A specimen in immature plumage was taken at Greenwich in 1912. Another, an adult, was trapped at Kingston in the winter of 1912, and kept in captivity for some months.

353. *Falco islandus* Brünn. WHITE GYRFALCON.—On the morning of Jan. 21, 1902, I saw a large bird flying at a height of about 150 yards overhead. The sky was heavily overcast with dark storm clouds, and against this sombre background the bird's white plumage stood out in bold relief. When first observed, it was sailing on steady wing; but as I watched it, greatly puzzled, the manner of flight changed suddenly, and I noted the quick wing-beats characteristic of the Duck Hawk. This bird I have always believed to be a White

Gyrfalcon; and while I know such a record is really of no scientific value, the above is given for what it is worth.

354b. *Falco rusticolus obsoletus* (Gmel.). Black Gyrfalcon. —Exceedingly rare winter visitant. One record; a female taken Jan. 8, 1898, on the Grand Pré meadows by my brother, Harold F. Tufts. This specimen is still preserved in the collection of William Brewster, Cambridge, Mass.

356. *Falco peregrinus anatum* (Bonap.). Duck Hawk.—Of rare and irregular occurrence. One observed Aug. 4, 1913, pursuing a flock of Semipalmated Sandpipers at Starr's Point beach. No records except for August and September.

357. *Falco columbarius columbarius* (Linn.). Pigeon Hawk. —Rare and irregular in occurrence. A few specimens taken in 1907; no record since till the fall of 1916, when one was observed at Black River.

360. *Falco sparverius sparverius* Linn. Sparrow Hawk.—Summer resident—fairly common about the sandy plains and sparsely wooded districts in the western part of the county. Occurs from middle of April to latter part of October. One record for winter, a male taken Jan. 7, 1899, by H. F. Tufts.

364. *Pandion haliaetus carolinensis* (Gmel.). Osprey; "Fish Hawk."—Rare. Formerly not uncommon in May and June, at which season they followed the fish up the Gaspereau River. Of late years I have no records, and these birds may be listed as "rare."

366. *Asio wilsonianus* (Less.). Long-eared Owl.—Rare. No record since Sept. 3rd, 1898, when a specimen was taken at Long Island. During 1897 and again

in 1898 a pair of these birds nested in the woods at Long Island, and all observations recorded were made during those two years.

367. *Asio flammeus* (Pont.). SHORT-EARED OWL.—Not uncommon on the Grand Pré dykes except in summer—for which season I have one record only, May 19, 1917. Of more frequent occurrence some years than others.

368. *Strix varia varia* Barton. BARRED OWL.—Uncommon permanent resident. Nests in May, sometimes using an old deserted crow's nest, or a hollow stub. Found in heavily wooded sections of the county.

371. *Cryptoglaux funerea richardsoni* (Bonap.). RICHARDSON'S OWL. — Very rare. Watson L. Bishop of Dartmouth (formerly of Kentville, Kings Co.) reports that one of these owls was taken in Feb., 1890, at North Alton, Kings Co., and was brought to him alive. This specimen was mounted and is at present in the Museum at Acadia College, Wolfville.

372. *Cryptoglaux acadica acadica* (Gmel.). SAW-WHET OWL.—Rare. Present throughout the year. A nest discovered Apr. 15, 1900, contained 5 eggs. On June 8, 1915, a young male was taken alive in the old nesting hole. It showed no fear, and perched on my finger, though strong and well able to fly, being fully grown.

373. *Bubo virginianus virginianus* (Gmel.). GREAT HORNED OWL.—Permanent resident, and probably our most common owl. Nests in February and March. Prefers heavily timbered regions. Many of these birds are killed every year by boys who set wire rabbit snares. The rabbit gets caught, and its pathetic far-reaching cry soon attracts the owl,

who speedily arrives and puts it out of misery. Next day the remains of the rabbit are discovered, a steel trap is set, and at night the owl, returning to finish his banquet, almost invariably walks into the trap. Five specimens so killed during the winter of 1915-16 were brought to me in the flesh.

376. *Nyctea nyctea* (Linn.). SNOWY OWL.—Irregular winter visitor. No observations except on the Grand Pré meadows. During the winter of 1902-3 these owls were common, and many specimens were taken by local gunners. None were since observed about this region until this winter (1916-17), when several were seen during December and January.

377a. *Surnia ulula caparoch* (Müll.). HAWK OWL.—Exceedingly rare. Two specimens were brought to my brother for identification in the winter of 1898. No other records.

388. *Coccyzus erythrophthalmus* (Wils.). BLACK-BILLED CUCKOO.—Summer resident, irregular and uncommon. On June 10, 1902, a nest of this species was discovered in an orchard, placed on a horizontal low apple limb, near the end and much exposed. This nest was a very rude affair, composed of a few twigs, crudely lined with two or three big dead maple leaves. On June 17 it contained three eggs. The occurrence of this bird about Wolfville appears to be more uncommon of late years.

390. *Ceryle alcyon* (Linn.). KINGFISHER.—Common summer resident in suitable localities. Occurs first week in May to second week of October. One observed Oct. 22, 1915. Most commonly seen along the shores of inland lakes and rivers, but occasionally in fall about the marshes, where they find the shoals of minnows in the shallow pools of brackish water

easy to capture and much to their liking. Nest in a sand bank, the tunnel being excavated to a depth of six or eight feet, ending in an enlarged chamber. This contains no lining. They lay five to seven eggs.

393a. *Dryobates villosus leucomelas* (Bodd.). NORTHERN HAIRY WOODPECKER.—Common permanent resident. During the nesting period these birds are seldom seen far from the heavily wooded sections, but during fall and winter they visit settled portions of the county. I have had one feeding regularly in my garden this winter on a piece of suet fastened to my feeding shelf.

394c. *Dryobates pubescens medianus* (Swains.). DOWNY WOODPECKER.—Common permanent resident. This species is more common than the Hairy Woodpecker, and closely resembles it except in size, being little more than half as large. Found about our orchards and ornamental groves at all seasons. A pair nest every year in a box provided for them in my garden.

400. *Picoides arcticus* (Swains.). ARCTIC THREE-TOED WOODPECKER.—Rare permanent resident. I have seen them during every month of the year—but of late years fewer are seen than formerly. Most records for winter months.

402. *Sphyrapicus varius varius* (Linn.). YELLOW-BELLIED SAPSUCKER.—Common summer resident, in suitable localities. Arrive last week in April and during the nesting season are found in the "backwoods" regions. They seem to prefer poplar trees for a nesting site and hence are most often seen in woods where these trees predominate. Like other wood-

peckers they excavate their own nesting cavities; and their eggs, 4 to 6 in number, are laid early in June.

405a. *Phlœotomus pil atus abieticola* (Bangs). Northern Pileated Woodpecker; "Devil's Woodpecker."—Rare permanent resident. This giant woodpecker haunts the deep forests remote from civilization, seeming to prefer the dark woods bordering swamp lands. On clear frosty days in March and early April I have heard these birds calling back and forth a mile or more across Black River lake. Their loud Flicker-like notes carry for a considerable distance. Last year, in the winter, I noticed a pair in the Black River region going in and out of a hole which they had drilled in a large poplar—a hole which I supposed was an old nesting site. I visited the place again in April. The birds were not there; and on examining the tree I found it to be hollow from the ground to the first limbs, some 35 feet or more. The pair were evidently using this place as a shelter during the winter storms.

412a. *Colaptes auratus luteus* Bangs. Northern Flicker; "Yellow-hammer." — Common summer resident. Occasionally observed in winter. Occurs regularly from the middle of April to latter part of October. One record Dec. 10, 1915, near Wolfville, another March 26, 1915.

417. *Antrostomus vociferus vociferus* (Wils.).—Whip-poor-will.—Rare summer resident. On the evening of June 11, 1915, I had the pleasure of hearing m first and only Whip-poor-will in this province, though I am familiar enough with the bird elsewhere. This occurred in a remote and lonely region of Annapolis County, only a few miles fro [illegible]

border of Kings, for which reason I feel justified in including it with these notes. I drove several miles back to an old deserted homestead, and as dusk came on I clearly heard the bird giving utterance to those familiar notes which there is no mistaking. I stayed there for a half hour, and the bird was still calling when I left. I was told by a woodsman living near the place that this bird had been heard every year since 1909, and had frequently been seen at dusk, on a certain flat rock. It appeared to be alone, not more than one being seen or heard.

420. *Chordeiles virginianus virginianus* (Gmel.). NIGHTHAWK.—Common summer resident. May 23 (8 years) to middle of September. Nests from June 10th to 20th in our burntlands, on the ground.

423. *Chætura pelagica* (Linn.). CHIMNEY SWIFT; "CHIMNEY SWALLOW."—Common summer resident. May 13 to Sept. 20. Nests about June 10th. A nest of this species was found a few years ago on a flat rock, ten feet down on the side of a stone well. Another was seen stuck to the perpendicular wall of an abandoned mill, about 12 feet from the floor, near Black River lake. Usually nest in a chimney.

428. *Archilochus colubris* (Linn.). RUBY-THROATED HUMMINGBIRD.—Summer resident, not uncommon. Occur from about May 16 to Sept. 1st. Most commonly observed about our flower gardens, but not infrequently in the heavily wooded regions to the south of Wolfville. A nest of this species was discovered on the horizontal dead limb of a hackmatack. The limb was covered with *Parmelia* lichens, of which the nest was a perfect imitation, resembling as it did a grey knot. It contained two eggs—a full set.

444. *Tyrannus tyrannus* (Linn.). KING BIRD.—Common summer resident. Arrives May 16th (10 years) and departs about Sept. 1st. Seen most commonly about our apple orchards. Nests on the horizontal bough of deciduous trees, but occasionally in low bushes, about the middle of June. The Kingbird is very regular in the date of his spring arrival here. In ten years records, the earliest "first seen" date is May 13th, the latest, May 18th.

459. *Nuttallornis borealis* (Swains.). OLIVE-SIDED FLY-CATCHER.—Fairly common summer resident. Arrives May 22nd (10 years), and seldom seen after the last week in August. I have not observed these birds near open sea coast; they seem to prefer settled districts of the Annapolis valley or the wildernesses to the south. Nests from June 10th to 20th.

461. *Myiochanes virens* (Linn.). WOOD PEWEE.—Summer resident, not uncommon and evenly distributed. Average date of arrival, May 26th. Seen often about the ornamental shady groves of the town, and as often in the remote heavily wooded regions. Nest in latter part of June using a horizontal limb of a large tree. The nest, like that of the Humming-bird, is covered with *Parmelia* lichens and closely resembles a knot on the limb on which it rests.

463. *Empidonax flaviventris* Baird. YELLOW-BELLIED FLY-CATCHER.—Uncommon summer resident. Arrives about June 1st, and like the other Flycatchers, leaves late in August. Observations mostly taken in deep shady woods, along the courses of rocky mountain streams. The bird is hard to approach, and is best recognized by its sweet, mournful call-note.

466a. *Empidonax trailli alnorum* Brewst. ALDER FLYCATCHER.—Fairly common summer resident. Arrives about May 28th (4 years), and leaves about Aug. 25th. Observed in alder swamps, rose-bush tangles, blackberry thickets and any waste land covered with thick bushes. Several pairs nest every year in a rose thicket near my house at Wolfville. They are very shy and their presence is almost invariably revealed by their characteristic note.

467. *Empidonax minimus* W. M. and S. F. Baird. LEAST FLYCATCHER.—Common summer resident, arriving about May 10th and leaving the latter part of August. This bird takes up its abode in our orchards and gardens, and though I have sometimes met with it in the heavily timbered regions, it always seems out of place there. Nests in apple trees, chiefly, about the middle of June. A nest once discovered in a hemlock—a most unusual site.

474. *Otocoris alpestris alpestris* (Linn.). HORNED LARK.—Winter visitor. Common locally. Seen on the Grand Pré from Nov. 1st to April 1st. Have never observed this bird far from salt water.

477. *Cyanocitta cristata cristata* (Linn.). BLUE JAY.—Permanent resident, common except in midwinter. During the nesting season Blue Jays are seldom seen away from the backwoods regions; but in the fall, when the corn begins to ripen, they appear about our farms and gardens. Some years they are quite common about the roadsides and orchards in winter. I have frequently fed fifteen or more on my lawn in severe weather.

484. *Perisoreus canadensis canadensis* (Linn.). CANADA JAY; "MEAT HAWK;" "CAMP ROBBER;" "CARRION BIRD;" "WHISKEY JACK."—Permanent resident, not uncommon locally. A resident of our evergreen forests, seeming to prefer the low-lying boggy spruce woods. They nest very early, about the middle of March. On March 10, 1914, one of these birds appeared in the hen-yard of a back-woods farm, and was seen carrying off feathers. On June 29th, 1915, I saw four fully grown, long tailed, nearly black immature specimens, accompanied by a pair of adult birds.

486a. *Corvus corax principalis* Ridgw. NORTHERN RAVEN.—Rather uncommon resident. Seen most frequently along the shores of the Bay of Fundy, where they nest on rocky ledges of the perpendicular sea-wall. They also inhabit the heavily wooded Black River and Forks River districts, where they seem to favor hemlock trees for nesting sites. A nest was discovered in a large yellow birch tree, April 15, 1917, and contained eix eggs.

488. *Corvus brachyrhynchos brachyrhynchos* Brehm. CROW.—Exceedingly common resident.

494. *Dolichonyx oryzivorus* (Linn.). BOBOLINK.—Summer resident, abundant, from middle of May to latter part of September. Most common on the Grand Pré near the salt marshes. Occasionally met with in the upland hayfields.

498 *Agelaius phœniceus phœniceus* (Linn.). RED-WINGED BLACKBIRD.—Exceedingly rare. A small flock—four or five—was seen feeding in a cat-tail swamp on the Grand Pré, Dec. 13, 1899. One specimen was taken by H. F. Tufts. This is the only record I have for this county. A nest of this species was reported from Colchester Co. a few years ago.

501. *Sturnella magna magna* (Linn.). MEADOW LARK.—Rare and accidental. One record only—a female taken at Bout Island near the mouth of the Gaspereau, Jan. 7, 1916 (R. W. T.). This bird was found on the salt marsh in a bleak and most exposed district, and had been seen there regularly for some days. It was feeding on the seeds of the marsh sedges which had not been cut the previous fall. Despite the fact that the marsh was exposed only in spots (being covered for the most part with slush and ice-cakes), the bird was in good condition, and was approached with difficulty.

509. *Euphagus carolinus* (Müll.). RUSTY BLACKBIRD; "BLACKBIRD"—Summer resident, common locally, from March 28th to middle of October. Observed chiefly in alder thickets, bordering lakes, rivers and swamps of outlying settlements. Nests commonly along the Forks river, a tributary of the Avon river.

511b. *Quiscalus quiscula æneus* Ridgw. BRONZED GRACKLE.—Common summer resident, arriving about first week in April. Seen more commonly about settled districts than in the wooded regions. Nests first week in May. Referring to my notes for 1896, I find that on May 3rd of that year I recorded my first "Purple Grackle;" this bird appeared in our garden, and I followed it for half a hour, studying it with my glasses. The following year on the 11th of April, a pair of these birds was seen in town, and one, a male, was taken and brought to me. It was then that I learned that this bird was not the Purple but the Bronzed Grackle. Since that year they have visited this region with marked regularity and in increasing numbers, until now they are common summer visitors.

515. *Pinicola enucleator leucura* (Müll.). PINE GROSBEAK; "WINTER ROBIN."—Permanent resident, apparently becoming more uncommon. Found chiefly about our evergreen woods in the southern part of the county. Two nests were found by H. F. Tufts about the middle of June in small coniferous trees. Until recent years it was believed to nest, like the Crossbills, during the winter season. About 1890 it was a common sight during the winter months to see small flocks of Pine Grosbeaks about the town feeding on the seeds of the ash tree. They were exceedingly tame, and attracted much attention. Since 1898 I have not seen them at all about town, but have made all my observations in the heavy woods. This winter (1917), however, I have observed a few specimens about our orchards feeding on the eggs of the canker-worm.

517. *Carpodacus purpureus purpureus* (Gmel.). PURPLE FINCH: "RED LINNET."—Common summer resident, occasionally seen in winter. Frequents our orchards, open woodlands and hedges. Nests about last of May, generally in coniferous trees.

——. *Passer domesticus domesticus* (Linn.). HOUSE OR ENGLISH SPARROW.—Abundant resident. An introduced species. The House Sparrow was introduced into this district by D. R. Eaton in 1878. Mr. Eaton, who was at that time one of the most progressive farmers and orchardists in Cornwallis, Kings Co., brought one or more pairs of the birds from Cambridge, Mass., hopefully anticipating that they and their progeny would prey upon a certain insect pest which was causing the farmers of the region much loss through damaged crops.

521. *Loxia curvirostra minor* (Brehm). AMERICAN CROSSBILL.—Of irregular occurrence throughout the year. Most common in June. Observed during fall, winter and early spring in the evergreen forests. In the summer months I frequently see them about the town and country roadsides in roving flocks of fifty or more, feeding on the ripening elm seeds. I have seen this bird nesting a few miles south of Wolfville during January, February and March of the years, 1902, 1906 and 1913. (See The Auk, vol. 23, July 1906, p. 339.)

522. *Loxia leucoptera* Gmel. WHITE-WINGED CROSSBILL.—Of irregular occurrence; less common than the preceding species. I have observed this bird every month of the year, but never away from coniferous trees. In January, February and March of 1902-'06-'13 they were common, and numbers nested in the coniferous woods within a few miles of Wolfville. (See The Auk, vo.l 23, July 1906, p. 339.)

528. *Acanthis linaria linaria* (Linn.). REDPOLL.—Irregular winter visitor—common some seasons, rare or absent others. During the spring of 1914 they were exceedingly abundant in this locality, and almost daily a flock, ranging in numbers from fifty to five hundred birds might be seen, even as late as May 1st. They were apparently all of the one species, which is the only one I have noted here.

529. *Astragalinus tristis tristis* (Linn.). GOLDFINCH.—Common summer resident; irregularly common in winter. Nests July 1st to 14th in hardwood trees. Often observed in March and April in large flocks. Seen in winter in smaller numbers.

533. *Spinus pinus pinus* (Wils.). PINE SISKIN.—Permanent resident, common some seasons, rare or absent others; very irregular generally. These birds seem to have no particular month for nesting; I have observed nests as early as April 27 (1913); and again as late as Aug. 4th (1898). My notes also show nesting records for every month between those mentioned. They were common during the winters of 1902-'06-'13, when the Crossbills nested here.

534. *Plectrophenax nivalis nivalis* (Linn.). SNOW BUNTING; "SNOW-BIRD."—Winter visitor, not so common as in former years. When they first arrive from the north, about Nov. 1st, these birds congregate in flocks on the Grand Pré meadows, and feed about the oat-fields with the Horned Larks. Flocks containing several hundreds are not uncommon. With the advent of winter and deep snow these flocks go further south, and the bird is no longer seen in large numbers. During January and February small flocks are noted about our orchards and withered gardens, but with less frequency and in smaller numbers than in former years.

536. *Calcarius lapponicus lapponicus* (Linn.). LAPLAND LONGSPUR.—Rare and irregular winter visitor. On February 8, 1916, I identified the Lapland Longspur—one specimen being taken on that date on the Grand Pré. From that date till March 2nd I frequently observed small numbers of these birds feeding on the Grand Pré with scattered flocks of Horned Larks and Snow Buntings, and other specimens were secured. Four of these specimens are now in the Provincial Museum at Halifax. No other authentic record for the province exists save

the reference to J. M. Jones having shot some on one occasion at Cole Harbour, Halifax Co., as mentioned in Downs's Catalogue of Birds of Nova Scotia (1888).

540. *Poœcetes gramineus gramineus* (Gmel.). VESPER SPARROW.—Common summer resident. Two records for winter, December 25, 1915 and January 21, 1916. Occurs from April 20th (9 years) to about November 1st. Nests on the ground in upland pastures.

542a. *Passerculus sandwichensis savanna* (Wils.). SAVANNAH SPARROW.—Common summer resident, from first week in April to first part of October. Abundant on the Grand Pré meadows and common about the upland pastures and mowing fields.

549.1a. *Passerherbulus nelsoni subvirgatus* (Dwight). ACADIAN SHARP-TAILED SPARROW.—Common summer resident on the meadows and marshes about Minas Basin. Never noted inland, or far from salt water. Occurs from middle of May to middle of October.

558. *Zonotrichia albicollis* (Gmel.). WHITE-THROATED SPARROW.—Common summer resident. Occurs from May 1st to Nov. 15th. Frequents our open woodlands and countryside groves, nesting among the ferns or in a brush pile. Frequently heard in full song as late as the middle of October.

559. *Spizella monticola monticola* (Gmel.). TREE SPARROW. —Irregular and uncommon winter visitor. Occurs from middle of November to April.

560. *Spizella passerina passerina* (Bech.). CHIPPING SPARROW.—Abundant summer resident, arriving May 1st (9 years). Frequents our gardens, orchards and waysides.

567. *Junco hyemalis hyemalis* (Linn.). SLATE-COLORED JUNCO.—Permanent resident, abundant in summer, not uncommon in winter.

581. *Melospiza melodia acadica* Thayer and Bangs. NOVA SCOTIAN SONG SPARROW.—Very common summer resident. A few spend the winter here. By the last week in March these birds are in full song, and are common until late in November. This new subspecies was described by J. E. Thayer and Outram Bangs from a series of specimens collected by the writer at Wolfville in April, 1914 (see Proc. New England Zoological Club, vol. 5, pp. 67-68, May 29, 1914). The type is number 65,643 in the Museum of Comparative Zoology, Cambridge.

584. *Melospiza georgiana* (Lath.). SWAMP SPARROW.—Common summer resident in suitable localities, occurring from May 1st to Oct. 1st. Noted in swampy or marshy ground covered with bushes, rank grass, cat-tails or weeds.

585. *Passerella iliaca iliaca* (Merr.). FOX SPARROW.—Common transient in spring and fall. Noted from April 1st to 25th in spring and from Oct. 1st to Nov. 10th in autumn. One record Dec. 13th, 1913. In the spring the Fox Sparrows appear about our gardens and hedges in small scattered flocks, and are heard singing gaily even when the ground is white with snow. During the fall migration they seem to prefer the covers and copses along the countryside. They do not nest in the province, Newfoundland being their chosen breeding ground.

595. *Zamelodia ludoviciana* (Linn.). ROSE-BREASTED GROSBEAK.—Uncommon summer resident. A few observed in the thickets and copses about the country.

During June (1915) a male was daily observed and heard singing in an apple orchard in Wolfville, but apparently he was unmated.

611. *Progne subis subis* (Linn.). PURPLE MARTIN.—Two records for this vicinity. On May 8th, 1914, a male was seen flying over Gaspereau village, and was readily identified by its dark color and familiar note. An effort has been made to attract them to my grounds at Wolfville but without success until June 14, 1917, when a female arrived and stopped for two days about a box I had erected. At Windsor, Hants County, I have seen these birds regularly for some years, and have watched them about their nesting boxes.

612. *Petrochelidon lunifrons lunifrons* (Say). CLIFF SWALLOW; "EAVE SWALLOW".—Common summer resident; from first week in May to middle of September.

613. *Hirundo erythrogaster* (Bodd.). BARN SWALLOW.—Common summer resident. Occurs from May 2nd (9 years) to middle of September. Two seen as late as October 5th (1915). This species, as well as the preceding one, has been much persecuted by the pugnacious House Sparrow, and this fact may account for the marked decrease in numbers in this and other localities. These birds are of inestimable value to the farmer, and no pains should be spared to afford them protection.

614. *Iridoprocne bicolor* (Vieill.). TREE SWALLOW.—Common summer resident. April 22nd (9 years) to about September 1st. Nests latter part of May. For some years two pairs have nested in boxes near my house, and the consequent absence of flies and mosquitoes in our immediate vicinity has been very marked.

616. *Riparia riparia* (Linn.). BANK SWALLOW.—Common summer resident about suitable nesting localities. Seen from first week in May till middle of September. They breed in large numbers in the high sand-banks at Long Island Beach and Starr's Point. Nest about June 1st.

619. *Bombycilla cedrorum* Vieill. CEDAR WAXWING.—Common summer resident. Rarely seen before last week in May, or later than last week of September. No records for winter. Nests latter part of June.

621. *Lanius borealis* Vieill. NORTHERN SHRIKE.—Formerly not uncommon winter visitor, occurring from December to April. Now rare and irregular. Two records for autumn, August 4th, 1913, and October 16, 1915.

624. *Vireosylva olivacea* (Linn.). RED-EYED VIREO.—Common summer resident, May 25th (9 years) to about September 1st. Nests latter part of June about our orchards and ornamental groves, but occasionally in localities remote from settled districts.

629. *Lanivireo solitarius solitarius* (Wils.). BLUE-HEADED VIREO.—Rather uncommon summer resident, arriving first week in May. Observed in the wooded regions. Nests early in June.

636. *Mniotilta varia* (Linn.). BLACK AND WHITE WARBLER. —Not uncommon summer resident, occurring from about May 8th to middle of September. Observed in open woodlands and shady coniferous groves. Nests about June 1st on the ground.

645. *Vermivora rubricapilla rubricapilla* (Wils.). NASHVILLE WARBLER.—Fairly common summer resident from first of May to first of September. Prefers open woodland areas with scattered hardwood trees Nests first week in June, on the ground.

647. *Vermivora peregrina* (Wils.). TENNESSEE WARBLER.—Rare summer resident. This warbler was first identified on June 1st, 1915. My attention was attracted by the loud and stirring song, which Chapman likens to the Nashville, though the latter has much less volume. The bird was hard to approach and exceedingly active, but with the aid of my binoculars I was soon satisfied as to the identity. Later I secured a specimen which I still have in my collection. Several were observed daily until about June 10th, when they disappeared from the locality. The next year, June 3rd, 1916, I saw three of these birds about the same vicinity and to my delight two pairs lingered about, and I soon discovered that they were nesting. On July 5th I saw the female feeding her young, and by July 10th they had flown. In June, 1917, the species was fairly common about Wolfville.

648a. *Compsothlypis americana usneæ* Brewst. NORTHERN PARULA WARBLER.—Common summer resident, from May 10th to Sept. 15th. Frequents woodland regions, particularly those sections in which the trees are covered with "beard moss" (*Usnea barbata*), of which the nest is cleverly constructed.

650. *Dendroica tigrina* (Gmel.). CAPE MAY WARBLER.—This is probably our rarest warbler. On June 2nd 1915, at Black River, I heard what I supposed to be the song of the Bay-breasted Warbler. Approaching nearer, I caught sight of the bird, hopping leisurely about on a small spruce. My glasses instantly told me I had stumbled on something unusual, a new bird for this region. Returning three days later, I found the bird in exactly the same locality, and by this time was able to identify

it as the Cape May Warbler. On June 4th of the following year (1916) I was surprised to find several in the old vicinity, all males. They were in a damp spruce wood, consisting of tall slender spruces—the sort of habitat which is favored by the Ruby-crowned Kinglet. Nearby was a more open stretch, on a little higher ground, with some birches showing among the spruces. This locality was too far from home to permit repeated observations, but I believe they nested there.

652. *Dendroica æstiva æstiva* (Gmel.). YELLOW WARBLER; "YELLOW BIRD."—Common summer resident from May 10 to September. One of our common garden birds, and seems to prefer living in close proximity to our houses.

654. *Dendroica cærulescens cærulescens* (Gmel.). BLACK-THROATED BLUE WARBLER.—Found in our heavy coniferous forests, remote from settled districts. Nests about the middle of June. Fairly common.

655. *Dendroica coronata* (Linn.). MYRTLE WARBLER.—Common summer resident, April 20th to November. One record as early as March 23rd (1909). Found in open woodland everywhere, preferring coniferous trees. Nests last of May.

657. *Dendroica magnolia* (Wils.). MAGNOLIA WARBLER.—Common summer resident from May 8th to September. Found in thickets of spruce and fir bordering open pasture land; also in shady groves of coniferous trees. Nests about middle of June.

659. *Dendroica pennsylvanica* (Linn.). CHESTNUT-SIDED WARBLER.—Fairly common summer resident, from May 12 to about first of September. Found most commonly about the dry hillsides, among the hardwood copses and thickets of the wooded areas.

660. *Dendroica castanea* (Wils.). BAY-BREASTED WARBLER. —Uncommon summer resident. Arrive regularly during the first week in June, when for a few days they are not uncommon. By the 10th they have moved on, and are rarely met with during the nesting period.

661. *Dendroica striata* (Forst.). BLACK-POLL WARBLER.— Not uncommon during the spring migration, June 1 to 10th. No records later than June 20th. For some inexplicable reason, these birds betake themselves for the nesting period to the small storm-swept islands off the southern coast of this province where they nest about July 1st.

662. *Dendroica fusca* (Müll.). BLACKBURNIAN WARBLER.— Uncommon summer resident. Found most frequently in the heavily timbered districts about Black River Lake, especially in sections where spruces and firs predominate.

667. *Dendroica virens* (Gmel.). BLACK-THROATED GREEN WARBLER.—Common summer resident, May 4 to Sept. 15th. Nests first week in June. Found commonly about the woodland pastures and in fact wherever there are enough coniferous trees to form a grove.

672a. *Dendroica palmarum hypochrysea* Ridgw. YELLOW PALM WARBLER.—Summer resident, common locally. During the spring and autumn migrations these warblers may be seen about our gardens and country roadsides. The nesting season finds them in the interior where they favor the peat bogs and broad barrens. I have frequently observed their nests about the middle of May.

674. *Seiurus aurocapillus* (Linn.). OVEN-BIRD.—Summer resident, common in suitable localities. Occurs from about May 20th to about the middle of September, in deep shady woods of mixed growth. Nest on the ground in early part of June, composed of moss, with an unique dome-shaped cover which completely screens the eggs from above. The entrance on the side resembles an oven, hence the bird's name.

675. *Seiurus noveboracensis noveboracensis* (Gmel.). WATER-THRUSH.—Not uncommon summer resident in the wilder and more remote parts of the county. My observations of this shy bird have usually been made near sluggish streams in the dense woods, where the thick tangled undergrowth affords him his coveted shelter and breeding ground.

679. *Oporornis philadelphia* (Wils.). MOURNING WARBLER. —Exceedingly rare summer resident. One record only, a male, taken at Black River on June 11, 1905, by myself. This specimen is now in the Provincial Museum at Halifax (acces. no. 2865).

681. *Geothlypis trichas trichas* (Linn.). MARYLAND YELLOW-THROAT.—Common summer resident, from May 15th to October. Observed most commonly in hardwood thickets, bordering wet areas, but also in upland pastures and open woodland where thick undergrowth occurs.

685. *Wilsonia pusilla pusilla* (Wils.). WILSON'S WARBLER. —Rare summer resident. One specimen, a male, taken in June 1895 (R. W. T.). A second male was taken June 7, 1917. No other observations for this region.

686. *Wilsonia canadensis* (Linn.). CANADIAN WARBLER.—Rather uncommon summer resident. Prefers damp swampy thickets and is generally observed near the ground. Two nests believed to be of this species have been found near here. They were similarly located, being well concealed in the mossy roots on the underside of an upturned tree. Both nests had been molested by some marauding jay or crow, and the eggs were broken.

687. *Setophaga ruticilla* (Linn.). REDSTART.—Common summer resident about gardens and ornamental trees, also observed in the wayside groves of the country. May 13th to Sept. 1st.

697. *Anthus rubescens* (Tunstall). AMERICAN PIPIT.—Formerly common during the fall migration, but much less so of recent years. Three specimens were taken Oct. 10, 1915, on the Grand Pré, two of which are now in the Provincial Museum at Halifax. Fall migration at this point lasts from about September 10th to November 1st.

704. *Dumetella carolinensis* (Linn.). CATBIRD.—Common summer resident. Last week in May to September, about our alder thickets, blackberry and raspberry tangles, especially when these occur near water and not too far from human habitation. Nests about middle of June. Until recently these birds were rarely seen within the confines of Wolfville. I remember with what delight I welcomed a pair to our garden raspberry bushes some twenty years ago—the first of the species I had ever seen inside the town limits. This pair mated and reared their young successfully. Since that date the Catbird seems gradually to have become a not uncommon garden bird, and in the spring of 1915, three

pairs nested not far from my house. The song is wonderfully rich, and the bird's imitative powers are quite unique and well developed.

722. *Nannus hiemalis hiemalis* (Vieill.). WINTER WREN.—Uncommon summer resident. More observations for October than for any other month. During the breeding season I never observe these birds except in the secluded wood-land regions, but in the autumn they are often seen about the brush piles and thickets nearer civilization.

726. *Certhia familiaris americana* (Bonap.). BROWN CREEPER.—Permanent resident, not common. In the spring and summer this bird is usually met with in the heavily timbered districts to the south; but in late fall and winter it is no uncommon sight about our orchards and shade trees. Its note is a mouse-like squeak, similar to that of the Golden-crowned Kinglet, but in April I have heard them burst into song which would do credit to any warbler. The first time I heard this surprising outburst I was at a loss to account for it, since the season was early and no warbler but the "Myrtles" had returned. I was quite amazed when, after careful search, I came upon the modest source, none other than the hitherto-supposed songless little creeper.

727. *Sitta carolinensis carolinensis* Lath. WHITE-BREASTED NUTHATCH.—Permanent resident, much less common than formerly. Only one observation for the nesting season, June 9th, 1913.

728. *Sitta canadensis* Linn. RED-BREASTED NUTHATCH.—Permanent resident, common some seasons, rare or absent others. The occurrence of this bird, like that of the Cross-bill and Pine Siskin, seems to

depend upon the abundance of the seed-bearing cones of the evergreens. Thus in 1902, 1906, 1913, when Crossbills nested in the county, Red-breasted Nuthatches were very common all winter, spring and summer. Other years their occurrence is rare and irregular, and what winter records I have were all made in the remote lumber woods.

735. *Penthestes atricapillus atricapillus* (Linn.). CHICKADEE.—Common permanent resident. Observed in spring and summer in wooded sections more or less remote from settled districts; in fall and winter, commonly seen about our orchards, hedge-rows and gardens. Nests late in May. This cheery little fellow responds readily to kind treatment. I have them feeding in my garden on bits of suet, bones, etc., all through the winter months. Last spring (1916) a pair nested in a box provided for them, and (due to the enforced absence of cats about our immediate locality) were able to get their brood off in safety.

740a. *Penthestes hudsonicus littoralis* (Bryant). ACADIAN CHICKADEE.—Permanent resident, fairly common. Rare some winters. Frequents evergreen trees and thickets, usually in low swampy land. Nests latter part of May. These birds rarely, if ever, leave the evergreen woods. They may often be seen in fall and winter feeding in twos and threes in company with the spry little Kinglets, but unlike the preceding species, do not venture into our orchards and gardens. Their note to me sounds like, "Sick-a-dee-dee"; while that of the other species is rather more clear-cut and more in keeping with the name—"Chick-adee".

748. *Regulus satrapa satrapa* Licht. Golden-crowned Kinglet.—Permanent resident, more common some years than others. Rarely observed far from the evergreen woods. These tiny birds build a most beautiful nest, usually pensile from near the end of long spruce limbs, concealed among the thick green sprays. The nest is ball-shaped, constructed almost invariably of green moss (*Schreiber's*) which is woven together with shreds of bark, plant down, bits of lichen, moss and hairs, and lined with feathers. They lay 8 to 10 small eggs, piled closely; and a cro ded nest full of young Kinglets is a laughable sight, and must afford a truly terrifying problem to the tiny parents.

749. *Regulus c lendula calendula* (Linn.) Ruby-crowned Kinglet.—Summer resident, of local distribution. Common in restricted areas. First appearance April 23rd (3 years). Most commonly observed during the breeding period in thick evergreen woods of spruce and fir—low-lying, mossy woods in unsettled districts seemingly preferred. In 1916 a pair of these birds nested on the "Ridge" near Wolfville—a most unusual occurrence.

756. *Hylocichla fuscescens fuscescens* (Steph.). Veery; Wilson's Thrush.—Rather rare summer resident. Seems to prefer the remote back-woods regions to the south, favoring the tangled alder thickets and swamps.

758a. *Hylocichla ustulata swainsoni* (Tschudi). Olive-backed Thrush.—Uncommon summer resident. Some years ago a nest was discovered at Long Island. It contained 4 eggs, and was built in a spruce tree (six feet up), in damp, coniferous woods.

759b. *Hylocichla guttata pallasi* (Cab.). HERMIT THRUSH.—Co mon summer resident. Occurs from last week in April to end of October. Nests about June 1st. Found in shady woods of mixed growth, seeming to prefer the proximity of a lake or river.

761. *Planesticus migr torius migratorius* (Linn.). ROBIN.—Abundant summer resident. Rather rare during the winter months. It is a generally accepted fact, I believe, that those robins which spend the winter in the Province are not our native birds, but rather are stragglers which have summered much fa ther north—this province being the southern limit of their range. During recent winters I have repeatedly seen them feeding on the frozen fruit of the common ground juniper, and their occurrence about here at that season is more common than formerl .

766. *Sialia sialis sialis* (Linn.). BLUEBIRD.—Rare and irregular. Two records only. Several seen September 2nd, 1910, at Kingston. These were feeding on rowan berries with the robins and had been there for several days. September 10, 1902, three were observed in an apple orchard near Wolfville.

List of Species known to Breed in the Grand Pré Region:

The following is a list of the 91 forms whose nests or fledglings I and my brother, Dr. H. F. Tufts, have personally seen in the region covered by my paper. It is presented in order to clearly indicate what species we have actually observed breeding here:

A. O. U. Nos. 7, 47, 51, 130, 133, 194, 228, 230, 263, 298, 300a, 331, 332, 333, 334, 337, 352, 360, 364, 372, 375, 388, 390, 393a, 394, 400, 402, 412, 420, 423, 428, 444, 459, 461, 463, 466a, 467, 477, 484, 486a, 488, 494, 509, 511b, 515, 517, House Sparrow, 521, 522, 529, 533, 540, 542a, 558, 560, 567, 581, 584, 595, 612, 613, 614, 616, 619, 624, 629, 636, 645, 648, 652, 654, 655, 657, 659, 662, 667, 672a, 674, 681, 686, 687, 704, 726, 728, 735, 740a, 748, 749, 758a, 759b, 761.

THE ORTHOPTERA (COCKROACHES, LOCUSTS, GRASSHOPPERS AND CRICKETS) OF NOVA SCOTIA; WITH DESCRIPTIONS OF THE SPECIES AND NOTES ON THEIR OCCURRENCE AND HABITS.—BY HARRY PIERS, Curator of the Provincial Museum of N. S., Halifax, N. S.

(Read 14 May 1917)

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PART 1. INTRODUCTION.

PART 1.—INTRODUCTION.

Purpose of this paper.—Twenty-one years ago I published in the Transactions of the Nova Scotian Institute of Science, volume IX, some preliminary notes on the Orthoptera of Nova Scotia. Since then other species have been found here, additional information has accumulated, and the nomenclature, in some instances, has changed. It now seems an opportune time to prepare a fuller paper which will contain all that can be gathered regarding these injurious insects in our province. Further investigation will add considerably to our information, will show the presence

of a few other forms, and disclose any errors that may have crept into this contribution; but in the meanwhile it will present what is now known on the subject.

One, and possibly the chief reason, why so very little attention has been given in this province, as well as elsewhere, to the study of these noxious insects, is the scarcity of works dealing with the whole order. In fact no general manual on the Orthoptera of North America is available, and the student has to consult many monographs in order to determine his specimens and to learn their habits. This has made the subject one which can only be taken up by a specialist; whereas, it should be possible for any intelligent farmer, after a little practice, to ascertain just what Orthoptera occur on his land, and which species are most liable to cause damage, for it is well known that many of them do great injury to crops.

In order, therefore, to help the beginner here, I will give descriptions of all our Nova Scotian species, with "keys" to more readily assist in identification, and notes on general distribution, in addition to more detailed observations on the occurrence and habits of the various species as observed in this province. All this will be useful in assisting those who really should know more than they do about insects of such economic importance, and who, no doubt, would gladly inform themselves on the subject if they had literature bearing directly on conditions in their own region. Orthopterists in general will also be interested in knowing what forms extend this far north, as it will aid them in working out the geographic range of the various North American species.

The purposes of this paper, therefore, are to enumerate all the species or forms known to occur here; to describe them so that the agriculturist, the local economic entomologist, and others, may be able to readily distinguish them; to present information as to their habits; to indicate what

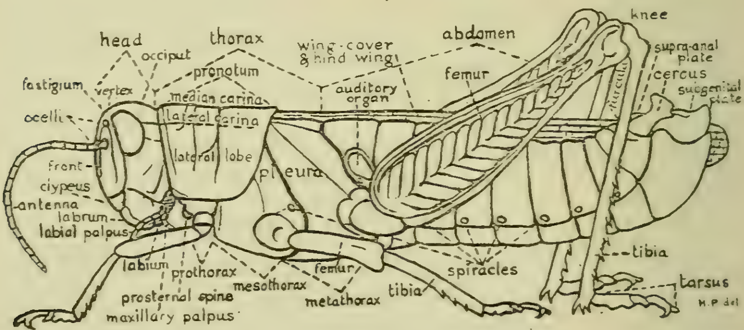
kinds are most liable to cause damage and how their depredations may be prevented; and, finally, to supply scientific men with data regarding the extension of the known geographic range of the various forms and with observations generally on these insects as found in Nova Scotia.

Lack of knowledge regarding Orthoptera—It is truly remarkable what little knowledge ordinary men have of our Orthoptera, although those insects are yearly pilfering many thousands of dollars from the hard-working agriculturist. Of the common indigenous species, even the intelligent layman knows almost nothing, except that he lumps together in his mind a number of different kinds of hopping insects which he sees in the grass, and vaguely terms them "grasshoppers," and the myriads of black crickets are to him just "crickets" and nothing more definite. Some of our most abundant species, such as *Scudderia pistillata*, with its remarkable form, bright green colour and strident call, are unknown to him by sight, and the greatest surprise is evinced when one is shown. How can we deal intelligently with orthopteran pests, when such ignorance is everywhere prevalent except among a few specialists? Nor is this true of our own province only, for similar conditions prevail fairly generally throughout America. No doubt the lack of convenient manuals for study, has had very much to do with the scant knowledge that exists in the public's mind regarding so many of the lower forms of life.

Orthoptera in General.

External anatomy of a locust.—At least a moderate knowledge of the superficial structure of a locust is necessary in order to understand descriptions. Very briefly, the external anatomy of a typical insect of this kind is as follows: There being no internal skeleton, the outside of the body is composed of a framework or exoskeleton of protective plates of cuticle hardened by "chitin" secreted by the cells of

the cuticle or skin. Thus the insect is defended very much like a knight of the gothic period. Besides being a defense, these plates are also a support for the whole insect's structure and serve for the attachment of muscles. Breathing is performed through several openings ("spiracles") on each side of the body, connected with a series of internal ramifying tubes. The organs of touch, and supposedly of smell also, are called "antennæ" and project like flexible horns from the front part of the head. The auditory organs or ears, when present, are in the basal segment of the abdomen in the *Acrididæ*, or in the fore tibiæ (rarely in the prosternum) in the *Tettigoniidæ* and *Gryllidæ*. The eyes consist of two large compound eyes and also usually three isolated simple ones ("ocelli").



The Principal External Parts of a Locust, *Melanoplus bivittatus*, male. The left wings removed. Magnified about 3½ times.

The body is divided into three main sections, (1) the "head," (2) the "thorax" which bears the organs of locomotion (wings and legs), and (3) the "abdomen." The part of the head behind the eyes is the "occiput", and that between and in front of the eyes is the "vertex"; the front of the head is the "face" or "front", and below is the mouth with its upper lip ("labrum") and lower lip ("labium") and the various parts of the jaws. The thorax is divided into three sections: (1) the front one is the "prothorax", and is covered

above and on the sides by the "pronotum", the upper and lateral surfaces of the latter being respectively its "disk" and its "lateral lobes", and the undersurface of the prothorax is the "prosternum" and bears the first pair of legs; (2) the middle section is the "mesothorax" which bears the fore-wings or "wing-covers" (when present), and the undersurface of the mesothorax is the "mesosternum" which carries the middle pair of legs; and (3) the hinder section is the "metathorax", and bears the thin "hind wings" (when present), and the undersurface of the metathorax is the "metasternum" and carries the hind legs which are usually stout and long and well adapted for leaping.

The wing-covers or tegmina act as shields for the hind-wings, and are leathery or parchment-like plates of chitin, strengthened by a network of "nerves" or "veins", the spaces enclosed by the nerves being termed "cells". The hind wings, used for flight, are thin and also strengthened with nerves or veins, but when not in use they are folded like a fan beneath the wing-covers. A few species have no wings or only rudimentary ones, and others have only the wing-covers. Many species are dimorphic as regards the length of the wings, both long- and short-winged variants being known. When reference is made to the front or "costal area", or to the hind or "anal area" of the wings, the supposed aspect is such as would be if the wings were extended sideways, at right-angles to the length of the body, not that of the wing when folded at rest. The hinder or leaping legs are the ones usually referred to in descriptions. Leaving out subordinate basal parts, their chief divisions are (1) the "femur", a long, stout, club-shaped segment, (2) the "tibia," which is also long but very slender, and (3) the "tarsus"or jointed foot. The joint between the femur and tibia is sometimes called the "knee".

The abdomen is composed of several segments, each made up of a "tergum"or dorsal part, and a "sternum" or ventral

part. The sides of the first abdominal tergum in short-horned locusts (*Acrididæ*) bear the "auditory organs" or ears. Along the sides of the abdomen are several "spiracles" or small external openings of the respiratory air-passages. The terminal abdominal segments are modified in each sex, as there are located the generative organs. The last tergum of the male locust is a triangular plate called the "supra-anal plate", at the base of which are usually a pair of minute processes called "furcula"; and to the second last tergum are attached two appendages called "cerci" which extend on either side of the supra-anal plate, and the form of which is sometimes, particularly in the *Melanopli*, an important character for the identification of species. The under portion of the last abdominal segment of the male is termed the "subgenital plate". The abdomen of the female ends in two pairs of plates, the "valves of the ovipositor"; and between them is the "ovipositor" proper or organ for depositing eggs.

In passing, it may be merely remarked that one of the most frequent questions regarding locusts asked by many people is, What is the so-called grasshopper "molasses" which most species readily exude from the mouth when handled? This brown-coloured fluid is secreted by salivary glands situated near the mouth-opening. It is also probably defensive in character.

Stridulation.—The call-notes of many species of Orthoptera are the most common insect sounds of late summer and autumn. Males alone possess musical organs which they use to call the opposite sex. Such organs, when present at all, are only in species which have wings, and wingless species also lack auditory organs. These call-notes are not vocal as many suppose; for owing to their peculiar mode of breathing through body spiracles and tubes without attached vibratory organs, insects have nothing which corresponds to a mammal's voice. The sound is produced

in various ways, by a sawing or rasping movement of parts on each other, as follows:—(a) By rubbing a series of minute elastic teeth situated near the lower margin of the inner surface of the hind femur, against a roughened vein of the wing-cover. This is done by raising and lowering the femur while the insect is otherwise at rest. This fiddling method is the one characteristic of most of the subfamily *Locustinæ* (Spine-breasted Locusts) and the subfamily *Acridinæ* (Oblique-faced Spineless Locusts), and may be readily observed in the case of *Chorthippus curtipennis*. Such species stridulate or call only during the daytime and the note is not loud. (b) By rubbing the under surface of the wing-cover against the upper surface of the front margin of the hind wings. This is performed only during flight, and in daytime, and is the usual method with the sound-producing members of the subfamily *Œdipodinæ* (Vertical-faced Spineless Locusts). It produces such notes as the cracking of *Circotettix verruculatus*. (c) By rubbing a particular vein or scraper-like part at or near the base of one wing-cover, against a file-like vein which crosses a resonant area at or near the base of the other wing-cover. This is performed by night as well as by day, by parting and closing the wing-covers while the insect is otherwise at rest. It is the method employed, with slight modifications as to the apparatus, by the sound-producing members of the family *Tettigoniidæ* (Long-horned Grasshoppers, omitting the silent Stone and Camel Crickets) and the family *Gryllidæ* (Crickets). Familiar examples are the strident call of the Katydids and the shrilling of the Ground and Field Crickets. Interesting records of orthopteran call-notes, many reduced to musical notation, will be found in two papers by Dr. S. H. Scudder, "Notes on the Stridulation of Some New England Orthoptera" (Proc. Bost. Soc. Nat. Hist., xi, 306-313, Bost., 1868) and "Songs of Our Grasshoppers and Crickets" (Ann. Rep. Ent. Soc. Ont., xxiii, 62-78, Toronto, 1893).

Terms used.—In preparing the descriptions in the following pages, as little use as possible has been made of technical terms, although a few will be found to constantly occur. These, with others of much less frequent use, are included in the following list of brief definitions, which will be convenient for reference, particularly when consulting other works wherein their use is more prevalent.

Abdomen.—Posterior part of body.

Adult.—The imago or perfect winged stage.

Antenna (-æ, pl.).—Elongated jointed organ of touch and possibly of smell attached to upper front part of head.

Apex.—Terminal portion of any part of body.

Basal.—Nearest to the body.

Brachypterous.—Having short or aborted wings in adult stage. (Opposed to Macropterous.)

Carina (-æ, pl.).—A ridge or keel.

Cercus (-i, pl.).—Appendage situated alongside of upper part of last abdominal segment.

Costal margin.—Front margin of wing-cover or wing when extended sideways.

Crest.—Sharp ridge or keel.

Dimorphic.—Exhibiting two forms, such as the long- and short-winged forms of a species.

Disk.—Middle portion of a surface, such as the disk of the pronotum, of the wing, or of the femur.

Dorsal.—Relating to the back or upper surface.

Dorsum.—Upper surface of thorax, abdomen, etc.

Elytron (elytra, pl.).—Wing-cover.

Fastigium.—Extreme point of front or vertex of head.

Femur (femora, pl.).—Thigh.

Foveola (-æ, pl.).—Small depression.

Front.—Face.

Furcula.—A pair of small backward-directed appendages of the last dorsal segment of male, and overlying the base of the supra-anal plate.

Fuscous.—Dark brown.

Glabrous.—Smooth.

Granulated.—With minute prominences which give a grainy surface.

Habitat.—Natural home or habitation of an animal or plant.

Hibernate.—Spend the winter in torpid state.

Hind wings.—Second pair of wings; the ones used for flight in Orthoptera.

Humeral.—Pertaining to the humerus or front upper corner or angle of the thorax or wing-cover. The subcostal vein of the wing-cover is also called the humeral vein.

Imago.—The adult or perfect winged stage.

Interspace.—Space between certain borders or adjoining spaces.

Knee.—Joint between femur and tibia.

Labium.—Lower lip.

Labrum.—Upper lip.

Lateral lobes of pronotum.—Bent-down portions covering sides of prothorax.

Macropterous.—Having long wings. (Opposed to Brachypterous in dimorphic forms).

Maxillary palpus (-i, pl.).—Moveable jointed organ attached to the maxilla, near mouth.

Mesonotum.—Upper surface of mesothorax.

Mesosternum.—Under surface of mesothorax.

Mesothorax.—Middle section of thorax, bearing wing-covers and middle pair of legs.

Metanotum.—Upper surface of metathorax.

Metasternum.—Under surface of metathorax.

Metathorax.—Hind section of thorax, bearing hind wings and hind legs.

Metazona.—Hind dorsal part of pronotum.

Nerves.—Large longitudinal ribs or veins of wing-cover and wings. The smaller connecting veins are nervules or veinlets.

Nymph.—Immature insect, active and feeding in larval and pupal stages, as in the Orthoptera. This constitutes what is known as Incomplete Metamorphosis. (Older nymphs may be distinguished from adults, or imagos as they are called, by having the wings small and apparently attached in an upside-down position, and by having the rudimentary hind wings outside of the fore wings, instead of beneath them as in the adult state).

Occiput.—Hinder part of head.

Ocellus (-i, pl.).—Simple eye, of which there are usually three, as distinguished from the large compound eye.

Ovipositor.—Female organ at end of abdomen, for depositing eggs.

Palpus (-i, pl.).—Moveable jointed organ attached to maxilla or labrum, near mouth; the former called maxillary palpus, the latter labial palpus. They are in pairs.

Pleuron (-ra, pl.) or Pleurite. —Side piece of mesothorax or metathorax, called respectively "mesopleuron" and "metapleuron," each of which is subdivided into an "episternum" (anterior part) and an "epimerum" (posterior part).

Pronotum.—Shield covering front part of thorax.

Prosternal spine.—Spine projecting from prosternum, between first pair of legs.

Prosternum.—Lower surface of prothorax.

Prothorax.—Front segment of thorax, bearing first pair of legs.

Prozona.—Front dorsal part of pronotum.

Pulvillus (-i, pl.).—Pad between claws of tarsus or foot.

Rugose.—Wrinkled or rough.

Segment.—Ringlike division.

Sinus.—Scooped-out marginal form.

Spiracle.—External orifice of breathing tube (situated on sides of the thorax and abdomen of an insect).

Sternum.—Under surface of body segment.

Stridulate.—To produce a shrill sound, by grating or rasping certain organs, as in the Orthoptera which do not produce vocal notes.

Subgenital plate.—Ventral portion of last abdominal segment of male, consisting of an upturned, spoon-shaped piece.

Sulcus (-i, pl.).—A linear groove.

Supraanal plate.—A triangular plate, the upper portion of the last abdominal segment.

Suture.—An impressed line; usually referring to the junction of two plates.

Tarsus (-i, pl.).—The foot, beyond the tibia; it consists of three divisions.

Tegmen (tegmina, pl.).—Wing-cover or front wing.

Tergite.—Upper portion of a body segment; tergum.

Testaceous.—Brick-coloured; dull yellowish brown.

Thorax.—Middle division of an insect's body, bearing the wings and legs; subdivided into prothorax, mesothorax, and metathorax.

Tibia (-æ, pl.).—Section of leg between femur and foot or tarsus.

Tubercle.—Small rounded projection.

Valves of the ovipositor.—Four horny plates at extremity of female abdomen.

Veins.—Same as the nerves or ribs of the wing.

Ventral.—Pertaining to the under abdominal surface.

Vertex.—Upper front part of head, between and before the eyes.

Wing-covers.—Front wings, tegmina, or elytra; not used for flight in Orthoptera, but serving as covers for the more delicate hind-wings.

Wing-pads.—Undeveloped wings, as seen on the nymph. From the wings of perfect or adult individuals (imagos) they may be distinguished by being seemingly in an upside-down position and by the rudimentary hind wings being outside the front wings.

Life history.—Generally the eggs of our Orthoptera are deposited late in the summer or early in the autumn. Most species lay them in a puncture in the ground formed by the ovipositor; but sometimes they are placed on the outside of twigs, as in the *Phaneropterinæ*, and occasionally in the pith of twigs, as in the Tree Cricket (*Œcanthus*). The eggs of most of our species then lie dormant until the next season when the small young insect, called a "nymph", emerges. This hatching, in the case of some species at least, such as *Camnula pellucida* and *Circotettix verruculatus*, takes place in western Nova Scotia about the first of June; but about Halifax it is apparently considerably later, *Melanoplus bivittatus* there hatching about the latter part of that month.

The eggs of the Grouse-locusts (*Acrydiinæ*) are laid much earlier in the season than those of most Orthoptera, and hatch in about three weeks, and the young reach maturity by the autumn, and then hibernate in the adult form, coming forth again early the next spring, about the middle of April in western Nova Scotia.

The Orthoptera have an incomplete metamorphosis, and do not pass through grub and chrysalis stages as many insects do. From the time they are hatched, they resemble the adult and are active and feeding, and merely grow and change in some minor details. In the first stage the nymph is wingless, but as it increases in size it moults its skin five times; and the wings, when they are to be present, gradually develop at these periods, but differ from those of the perfect insect in being seemingly placed upside-down and in having the rudimentary hind wings outside of the fore-wings. By these "wing-pads" the nymphs may be readily distinguished from adults. After the final or fifth moult, which takes place several weeks after hatching, they emerge as perfect insects or "imagos" as they are called, cease growing, and are ready to propogate their species and to continue the role of destructors of vegetation, until they finally die, usually when the harder frosts of autumn occur. Adults of the non-hibernating species begin to appear near Halifax towards the middle of July and about the first week of that month in the western counties. Nymphs are still seen for a few weeks after the adults begin to appear. Although the various call-notes of Orthoptera form a charming autumnal chorus in the country, and one which we would be very loath to lose, and they themselves are often clad in glad raiment and fair to look upon, yet they are a band of inveterate evil-doers, and deserve scant mercy from the economic entomologist and the farmer.

Parasites and other enemies.—Among the parasites which attack Orthoptera is a fungus, *Empusa grylli*, which is most

prevalent in wet seasons, and causes death. Many locusts are also attacked by a red mite, *Trombidium locustarum*, which clings to the body, and which no doubt is the species I have observed about Halifax infesting the underside of the base of the hind wings of *Melanoplus bivittatus* and *M. femur-rubrum* in August. Some species are also attacked by a hair-worm, a species of *Gordius*. They have likewise various insect enemies, as well as others among the reptiles, batrachians, small mammals, and birds. Unfortunately in Nova Scotia one of their least active enemies is their indirect victim man, except in the case of household pests such as the cockroaches. Among their friends we may possible include those who, having no crops to be injured, love them for their notable contribution to the sweet sounds of nature, particularly during the hush of night.

Injury caused by Orthoptera.—All of our Orthoptera are more or less injurious, some species doing great damage to agricultural crops and pasture-lands, particularly during a succession of dry seasons when the insects thrive and multiply rapidly, and the grass and other vegetation suffers directly from the drought. While this damage is no doubt not so great in Nova Scotia as in many parts of the United States, still it is quite extensive enough to seriously affect the farmer and more so than he has any idea of. Although, fortunately, that arch-devastator, the migratory Rocky Mountain Locust (*Melanoplus spretus*), does not range into eastern America, yet it has in these parts a very able representative in the closely related Lesser Migratory Locust (*M. atlanis*) which has a great potentiality for doing harm, and which, during some favourable seasons, is liable to produce much damage, a very serious instance of which occurred over twenty years ago on Sable Island, off the coast of Nova Scotia, to which fuller reference will be made when treating of the species. Had this insect not abated its ravages there, the grass which binds down the sand of which the island is composed, would

certainly have been ultimately destroyed, and the loose arenaceous deposit would then have drifted continually at the mercy of the prevailing southwesterly wind. In such a case, if this condition were not artificially checked, the island would in a comparatively few years have shifted eastward and become lower very much more rapidly than under normal conditions, and it would thus have ultimately gone beneath the sea-level, forming sandbars of tenfold greater menace to shipping than even the island is now.

The Red-legged Locust (*M. rubrum-femur*), existing everywhere in our pastures in vast numbers, must also do thousands of dollars' worth of damage yearly in the province; and the Yellow-striped Locust (*M. bivittatus*) no doubt produces considerable injury, as also the small Striped Ground-cricket (*N. fasciatus*) which in myriads infests our pasture lands, and its larger relative the Pennsylvanian Field-cricket (*G. pennsylvanicus*). The Clear-winged Locust (*C. pellucida*) is a pest in parts of the western counties, where in some seasons at least it is very abundant and harmful. Such species as frequent uncultivated lands and devour waste vegetation, may of course be considered as not of much economic importance, as their great voracity does not directly affect man to any noticeable extent. Cockroaches are serious pests in come city dwellings, bakeries and storehouses, but are very seldom if ever seen about cottages in the rural districts.

Methods of control.—The eggs of the Short-horned Locusts or *Acridïdæ*, which (with the exception of the Grouse-locusts) are laid in the ground late in the season and remain dormant until the following spring, may be killed by plowing the land in the autumn after the period of oviposition, so as to expose the eggs to the full effects of frost, etc. Poisoned bait may also be spread over the fields, as more fully described under *Melanoplus femur-rubrum*. Probably one of the very best and easiest methods is, when possible, to keep a

flock of poultry, particularly turkeys, the latter of which destroy vast numbers of locusts or grasshoppers, and such fowls command a ready sale. Methods of dealing with Cockroaches in houses and other buildings are described in the following pages where those species are described. A circular (No. 5) on the control of locusts in eastern Canada, by Arthur Gibson, was issued in 1915 by the Entomological Branch of the Canadian Department of Agriculture, Ottawa, and may be obtained on application to that department; and many thorough state reports on the subject of orthopteran control are published by the agricultural experiment stations of the United States.

Preserving Orthoptera for scientific purposes.—Specimens may be taken with an entomological hand-net, or in the manner known as sweeping; but it very frequently happens that they have to be stalked and captured by hand. The notes of many species draw attention to their whereabouts, and then by obtaining two cross-bearings the exact location of the individual can be ascertained, upon which it can be cautiously approached and taken. Further reference to this method will be found in the remarks on *Scudderia pistillata*, which is difficult to get in any other way. Specimens can be killed in a corked bottle of alcohol or in an entomological cyanide killing-bottle. The former is the safest for beginners to handle. On reaching home the insects should be either preserved in labelled vials in dilute alcohol or formaldehyde, the first of which, while it keeps the parts somewhat flexible for examination and prevents attacks by insect pests, will ultimately destroy some of the colours;* or else pinned with insect pins such as are used for entomological purposes, and afterwards systematically arranged

*Labels written with Higgins' waterproof drawing ink, black, may be placed into alcohol immediately after being written, and will not run or fade and are very much more legible than pencil-written labels. This I discovered many years ago and have used it in museum work ever since. So far I have not heard of others using this waterproof ink to supplement the lead-pencil for writing such labels, and the matter is one which should be of interest to all who have to deal with specimens preserved in jars where it is necessary to have a label within he jar in case the gummed label on the outside becomes detached.

in some form of tight insect-box or cabinet. The pin should be placed through the thorax, and the right-hand wing-cover and wing expanded horizontally and at right-angles to the body, so as to show their form and markings, while the left wing-cover and wing remain in a folded position. The legs should be neatly set in position so as to dry in a uniform posture. The long antennæ of some species are very liable to be broken when dry, and in such cases should be laid backward over the body where they will be less subject to injury. Some large-bodied species, such as *M. bivittatus*, are apt to discolour when dried, and therefore the contents of the abdomen should be removed through a small slit in the underside, and a little cotton-wool inserted to prevent collapse. On the pin, beneath the specimen, must be a small paper label having the specific name, if known, and always the place and date of capture. Without such data specimens are scientifically useless. Other general notes and observations should be recorded in a note-book, of which probably the loose-leaf ones are the best, as being expansive. Certain pages may be reserved for notes on each species, so that the information collected will always be orderly and readily available. I use such loose-leaf books, in which the notes are arranged systematically according to species, so that new records or observations are added directly under their proper heads, and new leaves are inserted whenever required. This method saves much labour in afterwards assembling one's notes.

ORTHOPTERA OF NOVA SCOTIA.

Historical notes.—So far as I can ascertain, nothing definite regarding the Orthoptera of Nova Scotia was published until 1869-70. Walter Bromley's anonymous "General Description of Nova Scotia", new edition, Halifax, 1825, page 33, gives a list of what he terms "most of the insects of Nova Scotia", the whole list consisting of only thirty-one common names, among which are merely mentioned the

"cockroach, grasshopper, cricket, and locust", the last probably referring to the Cicada. Haliburton, in his chapter on the natural history of the province, in his history of Nova Scotia, 1829, gives practically nothing about insects. J. W. Dawson's "Hand Book of the Geography and Natural History of Nova Scotia," third edition, Pictou, 1852, page 82, under the order Orthoptera dismisses the subject with a mere general reference to "the crickets and the grasshoppers, of which there are several species, all very injurious to vegetation."

Lieutenant Redman, many years ago, had collected a number of specimens in the province for the cabinet of the British Museum. He must have been here at least prior to 1848, as he is referred to as having obtained specimens of flies from Nova Scotia in Walker's "List of Dipterous Insects in the British Museum," the first volume of which was published in that year. Who this Lieut. Redman was, I have been able to conjecture with a large degree of certainty, for no doubt he was in the army, and it so the only man who could be he in the Army Lists from 1822 to 1849, is Lieut. Richard Sparrow Redman, who was commissioned lieutenant in the 60th (Royal American) Regiment of Foot in 1809 and served in that corps till 25th July, 1822, when he was placed on the half-pay of the 12th Light Dragoons, and died in 1833. From old Halifax almanacs, we find that "R. S. Redman" is named as senior lieutenant of the 2nd (lately the 3rd) Battalion, 60th Regiment, and that he was at Halifax in that corps from about 1820 (almanac for 1821) till at least the end of 1821 (almanac for 1822), so that no doubt he was here until placed on half-pay in July, 1822. Whether he thereupon returned to England is not known; but as we have said he died in 1833. We can therefore be quite reasonably certain that this was the "Lieut. Redman" who collected here, and that his collection

must have been made between about 1820 and 1822, unless he continued to reside here after he retired, which is not at all likely.

Francis Walker, F. L. S., when re-arranging the Orthoptera in the British Museum, studied and named Lieut. Redman's Nova Scotian Orthoptera, and references to them, twelve nominal species, was made in the former's "Catalogue of the Dermaptera Saltatoria in the British Museum," published in five parts at London, 1869 to 1870. This was the first real contribution to our knowledge of such insects in Nova Scotia; and Lieut. Redman is entitled to the credit of being the first to collect and F. Walker of being the first to make known our orthopteran fauna. In the "Canadian Entomologist," London, Ont., for February, 1872, vol. iv, No. 2, pp. 29-31, Walker published a list of the "Hemiptera, Heteroptera and Dermaptera (Orthoptera) of America to the North of the United States," the list of Orthoptera being on pages 30 and 31. In this list, which was merely selected from his previous larger work, he gives twelve nominal species of Orthoptera as occurring in Nova Scotia. Unfortunately Walker's determinations were occasionally erroneous, and so, owing to lack of confidence in his identifications and nomenclature, but very little use has been made of his list by recent American orthopterists. I have lately had Walker's Nova Scotian specimens re-examined at the British Museum, through the courtesy of Mr. B. M. A. Cummings of that institution, and am thus able in the present paper to assign for the first time, nearly all of his names to their proper species.

From the dates of Walker's lists until 1896 nothing apparently appeared on the subject, except a mere note on crickets at Windsor, N. S., by the present writer in the Transactions of the N. S. Institute of Science, vol. viii, p. 410, 1894. In August, 1895, I took up the study of these insects and collected about Halifax, the result being a pre-

liminary paper published in the Transactions of the Institute, vol. ix, pp. 208-218, 1896, which listed fourteen nominal species observed by myself, but which took no notice of Walker's records as the validity of his names were too doubtful in some instances to render quotation advisable. The determination of nearly all the forms listed by me were verified by the most noted of American orthopterists, the late Dr. Samuel H. Scudder of Cambridge, a gentleman who will long be remembered for his scientific knowledge, his general culture, and his refined and delightful personality. Other claims upon my time have since arisen; but many additional notes have been made, which with changes in nomenclature, have made it desirable that a revised list be prepared.

In the spring of 1913, Mr. Charles Benjamin Gooderham of the Agricultural College, Truro, N. S., began, under the direction of the then Provincial Entomologist, Dr. Robert Matheson, the collection and study of Orthoptera about that town and the western counties of Nova Scotia, where the faunal conditions are considerably different from those of the Atlantic seaboard. He has since continued this work, and in 1914 founded the orthopteran collection at the before-mentioned college and has likewise built up a collection of his own. He has just published a paper on the Acrididæ of Nova Scotia in the Proceedings of the Entomological Society of Nova Scotia for 1916, no. 2 (Jan., 1917), pp. 21-30, which lists thirteen forms. To the kindness of Mr. Gooderham, who has most courteously placed many of his notes at my disposal, we are indebted for the inclusion in our list of some interesting species which I have not met about Halifax, and through his observations the relative abundance of species in the eastern and western sections is better understood. Mr. Gooderham was lately assistant provincial entomologist at Truro.* Mr. E. Chesley Allen,

*In 1917 he was transferred to the Central Experimental Farm at Ottawa as Assistant Dominion Apiarist.

now of Truro, has also collected to some extent in our southernmost county of Yarmouth, and references to his work will likewise be found in my paper. I have also examined such small entomological collections as are shown at the Provincial Exhibitions to ascertain what Orthoptera they contain.

Bibliography.—The following publications deal more or less fully with Nova Scotian Orthoptera or contain original records of occurrences in this province. Bromley's and Dawson's very brief references, beforementioned, are too short and general to list.

1869-70 [71].—Walker, Francis, F. L. S., etc. Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum. 8vo.

[Part I.] Gryllidæ, Blattariæ, Locustidæ. Pp. 1-224. Lond., 1869.

Part II. Locustidæ (continued). Pp. 225-423. Lond., 1869.

Part III. Locustidæ (continued), Acrididæ. Pp. 425-604. Lond., 1870.

Part IV. Acrididæ (continued). Pp. 605-809. Lond., 1870.

Part V. Tettigidæ. Supplement to the Catalogue of Blattariæ, Supplement to the Catalogue of Dermaptera Saltatoria (with remarks on the Geographical Distribution of Dermaptera). Pp. 811-850; 1-43; 1-116. Lond., 1870 [1871].

In this work 12 nominal species are noted as having been collected in Nova Scotia, the original labels showing that they were taken by the beforementioned Lieut. Redman, who was here at least some years prior to 1848 and probably from 1820 to 1822. (See page 216).

1872.—Walker, Francis, F. L. S. Hemiptera, Heteroptera and Dermaptera (Orthoptera) of America to the

North of the United States. Dated Jan., 1872. Canadian Entomologist, London, Ont., vol. 4, no. 2 (Feb., 1872), pp. 29-31. (The list of "Dermaptera [Orthoptera]" is on pp. 30-31.)

Lists 12 nominal species as occurring in Nova Scotia, the same as noted in his previous Catalogue.

1892.—Scudder, Samuel H[ubbard]. The Orthopteran Genus Hippiscus. Psyche, vol. 6, Cambridge, 1892, pp. 265-274, 285-288, 301-304, 317-320, 333-336, 347-350, 359-363.

On page 303 is a reference to "*H. tuberculatus*" [=*H. apiculatus* Harris] as occurring in Nova Scotia, with the name of "Jones" attached. It is the sole record for its occurrence here as far as known. See remarks in the present paper, under *H. apiculatus* (No. 11).

1894.—Piers, Harry. Notes on Nova Scotian Zoology; no. 3. Trans. N. S. Inst. Sc., vol. 7, Halifax, 1894, pp. 395-410.

On page 410 is a brief note on Crickets, "*Acheta abbreviata*" (=*Gryllus pennsylvanicus neglectus*) and *A. vittata* (=*N. fasciatus vittatus*) at Windsor, N. S.

1896.—Piers, Harry. Preliminary Notes on the Orthoptera of Nova Scotia. Trans. N. S. Inst. Sc., vol. 9, Halifax, 1896 (separates issued Nov.), pp. 208-218.

Annotated list of 14 nominal species collected about Halifax in 1895-6.

1899.—Scudder, Samuel H. North American Species of Orphulella. Can. Entomologist, vol. 31, no. 7, London, Ont., July, 1899, pp. 177-188.

On p. 184 is the only record of *Orphulella speciosa* having been taken at Halifax by Piers. See remarks on this doubtful record in the present paper. From 1896 until Scudder's death in May, 1911, many of his papers contained references to the occurrence

of various species in Nova Scotia, all based on my paper of the former date, but there is no need to refer to them here, as they are merely secondary references, not original records.

1917.—Gooderham, C[harles] B[enjamin]. The Acrididæ of Nova Scotia. Proc. of Entomological Society of Nova Scotia for 1916, no. 2, [Truro], Jan., 1917, pp. 21-30, and 1 plate.

Lists 13 nominal species, with keys and descriptions. The material for this paper was collected during 1913 and 1914 and it was founded on the author's thesis for his degree of B. S. A. at Macdonald College, Ste. Anne de Bellevue.

Reference works.—Among the available literature which will probably be most useful to a student of the Orthoptera of this section of Canada, may be mentioned the following papers of recent dates, from which it will be seen that there is no general manual on the subject, and one is therefore forced to rely upon various scattered sources of information.

1894-98.—Morse, Albert P. Notes on the Acrididæ of New England. Psyche, vol. 7 (Cambridge, 1894-97), vol. 8 (1897-98).

1897.—Scudder, Samuel H. Guide to the Genera and Classification of North American Orthoptera. Cambridge, 1897. (Keys to the various genera, without reference to species. Contains a bibliography.)

1897.—Scudder, S. H. Revision of the Orthopteran Group Melanopli. Proc. U. S. Nat. Mus., vol. 20, Wash., 1897, pp. 1-421, pl. 1-26. (A very thorough monograph of an important group.)

1898.—Scudder, S. H. The Orthopteran Group Scudderiæ. Proc. Am. Acad. Arts and Sc., vol. 33, no. 15, Bost., 1898, pp. 269-290, with plates. (Clears up this hitherto chaotic group.)

1898-1901.—Walker, E. M. Notes on Some Ontario Acridiidæ. Can. Ent., vol. 30, Lond., Ont., 1898, pp. 122-126, 258-263; vol. 31, 1899, pp. 29-36, vol. 33, 1901, pp. 20-23. (Useful for comparative purposes. Lists 35 nominal species with notes on habits. In vol. 34, 1902, pp. 251-258, he extended the list to 47 species.)

1900.—Scudder, S. H. List of the Orthoptera of New England. Psyche, vol. 9, no. 293, Cambridge, Sept., 1900, pp. 99-106. (List of 98 species; useful for comparison.)

1901. Scudder, S. H. Catalogue of the Described Orthoptera of the United States and Canada. Proc. Davenport Acad. of Sc., vol. 8, Davenport, Iowa, 1901, pp. 1-101. (List of 856 species, with synonyms and geographic range.)

1901.—Scudder, S. H. Alphabetical Index to North American Orthoptera described in the 18th and 19th centuries. Occasional Papers, Bost. Soc. Nat. Hist., vol. 6, Boston, 1901, 436 pp. (List of specific names, authorities and localities, without reference to synonymy; of much use to the working orthopterist. An exhaustive bibliography is given on pp. 349-399.)

1903.—Blatchley, W. S. The Orthoptera of Indiana. 27th Ann. Repot. Dept. of Geol. and Nat. Res. of Indiana, 1902, Indianapolis, 471 pp. Author's separates issued 5 Sept., 1903. (Although this deals with a particular region and one somewhat far removed from us, still it is one of the very best available manuals which our student can use, and fully describes a large proportion of the species found here, with keys, illustrations, and a bibliography.)

1904.—Walker, E. M. The Crickets of Ontario. Can. Ent., vol. 36, London., Ont., 1904, pp. 142-144, 181-188, 248-255. (Useful for comparative purposes. Lists 14 nominal species, with notes on habits, etc.)

1904-5.—Walker, E. M. Notes on the Locustidæ of Ontario. Can. Ent., vol. 36, Lond., Ont., 1904, pp. 325-330, 337-341; vol. 37, 1905, pp. 34-38, 113-119. (Useful for comparative purposes. Lists 26 nominal species with notes on habits, etc.)

1911.—Walden, Benjamin Hovey. The Euplexoptera and Orthoptera of Connecticut. Part 2 of Guide to Insects of Connecticut, Conn. State Geol. and Nat. Hist. Surv., Bulletin 16, Hartford, 1911, pp. 39-169, with illustrations. (A useful work with simple keys, descriptions, and illustrations.)

1914.—Somes, M. P. Acridiidæ of Minnesota. Univ. of Minn. Agric. Expt. Station, Bulletin 141, St. Paul, 1914, 98 pp., with coloured plates. (Contains keys for determination of species, and notes on occurrence and habits.)

1915.—Walker, E. M. Notes on a Collection of Orthoptera from Prince Edward Island and the Magdalen Islands, Que. Can. Ent., vol. 47, Lond., Ont., Oct., 1915, pp. 339-344. (The specimens listed were collected by Bayard Long, a botanist, in P. E. Island in 1912, and in Quebec in 1910. It furnishes the only list of species occurring in Prince Edward Island, of which it enumerates 11 nominal forms, and therefore is of unusual interest to students in this region.)

For some original descriptions one is thrown back to Scudder's "Materials for a Monograph of North American Orthoptera," listing 78 species, in Journ. Bost. Soc. Nat. Hist., vol. 7, Bost., 1862, pp. 409-480, which is now difficult to obtain. Sidney I. Smith's "Orthoptera of Maine," in Proc. Portland Soc. Nat. Hist., vol. 1, Portland, 1869, pp. 143-151, lists 38 nominal forms, but is out of print; as is also C. H. Fernald's "Orthoptera of New England," Boston, 1888, pp. 61, illustrated, and F. B. Caulfield's "Sketch of Canadian Orthoptera", containing a preliminary list of 76

nominal species in 18th Ann. Rep. Ent. Soc. Ontario for 1887, Toronto, 1888, pp. 59-72 (Sess. Papers Ont. for 1888, pt. 4, no. 21). Caulfield's list gives no Nova Scotian records.

For general purposes our student will probably find Blatchley's "Orthoptera of Indiana" (1903), and Walden's "Euxlexoptera and Orthoptera of Connecticut" (1911) the most useful guides in the determination of species, etc.

Life zones represented in Nova Scotia.—Two of the recognized Life Zones are represented in this province, namely (a) the *Canadian Zone* and (b) the *Alleghanian division of the Transition Zone.* The former is the southern portion of the Boreal Region, and the latter is the northeastern transitional portion of the Austral Region. The Canadian Zone, with its more northern fauna and flora, includes Cape Breton Island (excepting doubtless the valleys of the Margaree and Middle Rivers) and the Atlantic slope of Nova Scotia proper, southeast of a line, of irregular course, roughly drawn from near Antigonish to Grand Lake and thence to near Yarmouth. It may therefore be taken to approximately comprise the greater part of Cape Breton Island, and the Atlantic seaboard counties of Guysborough, Halifax, Lunenburg, Queens and Shelburne, and perhaps is most typically represented from Halifax eastward. It is quite possible that the highlands of northern Inverness and Victoria Counties, Cape Breton Island, may contain a fauna and flora approaching somewhat more to that of the Hudsonian Zone; and at any rate in that district will be met life of the most northern type to be found in Nova Scotia.

Westward and northwestward of the above-defined area occurs a fauna and flora of a more southern tendency, belonging to the Alleghanian or humid division of the Transition Zone. The Alleghanian division roughly includes such sheltered valleys, apparently, as those of the Margaree and Middle Rivers, in Inverness and Victoria Counties, (Cape Breton Island), and all or most of the counties of Antigonish,

Pictou, Colchester, Cumberland, Hants, Kings, Annapolis, Digby, and Yarmouth, with various subsidiary offshoots or tongues, such doubtless as the valleys of the Shubenacadie, Stewiacke, and Musquodoboit Rivers, etc., and probably the district about the headwaters of rivers like the LaHave. Generally it embraces the counties on Northumberland Strait and the Bay of Fundy, with outlying areas in sheltered inland districts. This region is probably most typical from Truro, through the Annapolis Valley, to Yarmouth. Outliers of the Canadian Zone will no doubt be found in some elevated districts in this Alleghanian region. A detailed delineation of the life zones of this province is greatly needed, and most certainly should be prepared through the cooperation of our local biologists.

Thus we find in the western parts of the province a number of species which are rare or wanting on the Atlantic side and which are more southern in range. It is in this western area that we are more likely to find species of Orthoptera which have not yet been reported from the province; species which form the last northern outposts of some of the New England forms. As Maine embraces similar life zones to those of Nova Scotia, it is the common species in that state which are most likely to be found extending into Nova Scotia until they arrive at the northernmost limit of their distribution. These considerations explain to a large extent the variation in the relative abundance of certain species in the eastern and western sections of our province, to which reference will be made later. The passing out of species of more southern range, and the lack of any augmentation from species of more northern distribution, have made our orthopteran fauna a very scanty one when compared with that of regions to the south of us. (See further remarks under the heading "Number of species in Nova Scotia", page 233.)

The distribution of Nova Scotian Orthoptera according to life-zones may be very roughly and quite tentatively set down as follows, although sufficient is not yet definitely

known regarding the relative abundance of some species to make the grouping at all definitive. It is therefore merely a suggestive grouping, prepared specially to court subsequent revision which will bring us nearer the facts.

Canadian Zone.

(Atlantic seaboard and eastern Nova Scotia).

Chorthippus curtipennis†
Dissosteira carolina†
Circotettix verruculatus†
[*Podisma glacialis*. Hypothetical.]
Melanoplus atlanis†
[*Melanoplus fasciatus*. Hypothetical.†]
Melanoplus femur-rubrum†
Melanoplus bivittatus (phase *femoratus*)†
Scudderia pistillata†
Conocephalus fasciatus fasciatus†
Nemobius fasciatus (variant *vittatus*)†
Gryllus pennsylvanicus (variant *neglectus*)†

All these species also occur commonly in the Alleghanian (western) section of the province, except of course the two species which are merely hypothetically included in our fauna. *Podisma glacialis*, if actually found here in the future, will most likely occur in the Canadian Zone; and *Melanoplus fasciatus*, another hypothetical inclusion, should certainly be associated with the same zone.

Alleghanian Division of the Transition Zone.

(Western Nova Scotia).

*Nomotettix cristatus**
Acrydium granulatum†
Acrydium arenosum angustum
Orphulella speciosa (although actually only reported from Halifax; a very doubtful record).*†
*Mecostethus lineatus**†
*Mecostethus gracilis**
*Camnula pellucida**†
Hippiscus apiculatus†
Melanoplus extremus
Scudderia curvicauda borealis
Scudderia furcata furcata (although actually only reported from Halifax).*†
Ceuthophilus maculatus†
Ceuthophilus terrestris
Nemobius carolinus†

Those species marked with an asterisk * have also been reported from eastern Nova Scotia, and therefore pass into the more northern Canadian fauna, but they appear to me to be more particularly associated with the Transition group. *Scudderia furcata* and *Orphulella speciosa*, although only reported from Halifax (the latter on the authority of Scudder who states I collected it here), seem to have greater relationship to the more southern fauna of western Nova Scotia, and are so grouped for the present. The occurrence of *Hippiscus apiculatus* and *Orphulella speciosa* is open to very considerable doubt, but we would expect them to pertain to the Transition Zone.

The species marked with a † apparently range, in other parts of the continent, still further downward into areas believed to belong to the Carolinian division of the Upper Austral Zone, although their supposed presence in that zone may sometimes be explained by the existence in those parts of small unmapped outlying areas of Transition fauna.

Influence of climate and periodical phenomena on Orthoptera.—As the hatching of orthopteran eggs and the final autumnal disappearance of a species, as well as its abundance to a large extent, are dependent upon climatic conditions, the following relevant data for Nova Scotia are furnished, which may be useful to future students.

Mean annual temperature	Fah. 44.4°
Maximum temperature	94.4°
Minimum temperature	-16.9°
Mean temperature, spring months	40.3°
Mean temperature, summer months	62.3°
Mean temperature, autumn months	49.1°
Mean temperature, winter months	25.8°
Warmest months,	July, 64.9°; Aug. 64.5°
Coldest months,	Feb., 23.7°; Jan. 24.4°
Mean annual precipitation, inches	57.40
Least precipitation, July, mean, inches	3.66

The above data refer to Halifax, and is only approximately correct for the province generally, as the western section is considerably warmer in summer, and also differs somewhat in other meterological features.

The dates of certain periodical phenomena for several recent years may be given approximately as follows, for Nova Scotia in general:*

Grass begins to sprout at Halifax about 18th April (extremes 14—24 Apr.).

Ploughing, first, 24 April (extremes, 15 Ap.—3 May); becoming common, 5 May (extremes, 28 Ap.—19 May).

Sowing, first, 7 May (extremes, 27 Ap.—19 May); becoming common, 14 May (extremes, 6-19 May).

Haycutting, first, 16 July (extremes, 11—25 July); becoming common, 26 July (extremes, 20 July—3 Aug.).

Last snow, to whiten ground, 21 Ap. (extremes, 13—26 Ap.); to fly in air, 4 May (extremes, 26 Ap.—20 May).

Last spring frost, hard, 13 May (extremes, 4—20 May); hoar, 3 June (extremes, 29 May—9 June).

First autumn frost, hoar, 20 Sept. (extremes, 13—29 Sep.); hard, 16 Oct. (extremes, 5—31 Oct.).

First snow, to fly in air, 20 Oct. (extremes, 14—27 Oct.); to whiten ground, 6 Nov. (extremes, 31 Oct.—14 Nov.).

We have said that the temperature of the western section of Nova Scotia, where the Alleghanian fauna is found, is higher than that of the Atlantic seaboard and eastern section, where occurs the Canadian fauna; and one may expect something like a week's difference in the dates of periodical phenomena when the two districts are compared. This must be borne in mind when considering the dates of the first and last appearances of our Orthoptera in various counties.

No Orthoptera, either hibernated adult or nymph, can emerge until after the ordinary winter's frost is out of the

*Compiled from Dr. A. H. MacKay's Phenological Observations, in Trans. N. S. Inst. Sc.

ground, and we take it for granted that no eggs hatch till after the last hard spring frost which occurs about the 13th May. It is even probable that hatching does not take place generally till after the last hoar frosts of about 3rd June, unless it be in the case of a very few hardy species such as *M. atlanis*, *M. femur-rubrum*, and *C. curtipennis*.

The earliest species of Orthoptera to appear as adults are those of the subfamily *Acrydiinæ* or Grouse-locusts. These insects are peculiar, inasmuch as oviposition takes place early in the season and the young hatch and reach maturity by the autumn, and then hibernate as adults, to reappear the next spring. Of these, *Acrydium granulatum* and *Nomotettix cristatus* have been taken in western Nova Scotia on 15th April, just as the grass was beginning to sprout, which is not very long after the winter's frost has come out of the ground, and long before the last hard spring frost which occurs about 13th May (4—20th May). Other species of *Acrydium* are also very early in appearing, as they all belong to the hibernating *Acrydiinæ*.

The non-hibernating species, which embrace about eight-ninths of our forms, hatch and appear as nymphs and adults at a much later date than the hibernated adults of the *Acrydiinæ*. The first newly hatched orthopteran nymphs noted by C. B. Gooderham about Truro in 1915, when he was observing the hatching of the eggs fairly closely, were seen on 3rd June, which is about the usual time of the last hoar frost. The tiny hoppers could then be seen in very warm places. They were chiefly *Camnula pellucida* with a few *Circotettix verruculatus*. Other species were present but were not determined. About Halifax the date would be considerably later. On 1st July, 1917, I collected the nymph of *Melanoplus bivittatus* in the second stage, near Halifax. It must have hatched about the middle or latter part of June.

The adults of most species appear during July, our warmest month; while *Scudderia* and a very few others come in

later, about the first week of August. For a considerable time, nymphs and adults of the same species may be collected together, showing that the period of hatching extends over a considerable number of days. August and most of September are the months when the song-making species are most loudly heard, although the notes of some species are still heard in October, but are then less vehement. Oviposition probably takes place fairly generally in September, but we have little data on this point. In the case of the Grouse-locusts (*Acrydiinæ*) it must be much earlier, as these insects pass through the egg stage and come to maturity in the same season before hibernating.

Generally speaking, the first hoar-frost of about 20th Sept. (13—29th Sept.) has little effect upon our Orthoptera, unless it is to lessen the volume of their notes; except in the case of the very frail *Conocephalus fasciatus* which succumbs to the lowering temperature in the middle of that month. The first hard frosts which usually occur about 16th Oct. (15—31 Oct.), appear to be the critical factor which determines the existence of a large number of our Orthoptera, although the Crickets, our hardiest species, often survive as late as about the middle of November, and in one instance, in 1916, four inches of snow fell only two days after the last Ground Crickets (*Nemobius*) were seen. The middle of November is therefore the close of our orthopteran year which had opened in the middle of April and had reached its culmination about the last part of August and the first part of September. A few individuals, in rare instances, are able to casually survive sometime longer by getting into hay-ricks or other sheltered nooks, from which they languidly crawl on a sunny day.

A succession of dry summers and perhaps of winters when the soil is not much affected by thaws and severe frost, seem favourable to the multiplication of Orthoptera; the largest numbers, I believe, being met after such conditions.

Melanoplus atlanis, a species which should be closely watched because of its latent destructive abilities, is liable to appear in vast numbers after such seasons. The dry summers of 1889, 1891 and 1894, even though a fairly wet one intervened in 1893, seem to have had something to do with the plague of that species on Sable Island which began about 1891; and the wet season of 1896 suddenly caused its disappearance. Meteorological records show that Nature has fortunately provided a counteracting influence in such matters, as periods or years of great drought are soon succeeded by years of abnormal rainfall. For the suppression of many pests we apparently owe more to the balancing efforts of Nature, exerted in various ways, than to man's own exertions; although it must be admitted, inversely, that it is often the cause of the periodical multiplication of such pests.

Earliest and latest appearance of adults.—The following provisional table of the earliest and latest dates on which adults of the various commoner species have happened to have been noted in Nova Scotia, is inserted chiefly that it may be a convenient reference list for students who have data which may modify the dates here given. One of its purposes, therefore, is to court correction, and another is to assist the student by cautioning him beforehand when to look for the appearance and disappearance of the various species. No doubt considerable changes can be made in some parts of the table by further investigation. Some rare forms are not included, as the dates on which they have been taken manifestly could not be considered as earliest or latest occurrences.

Species	First appearance		Last appearance	
	Date	Place	Date	Place
Nomotettix cristatus (hibernating species)	15 Apr.	Truro	20 Aug.	Truro
Acrydium granulatum (hibernating species)	15 Apr.	Truro	4 Oct.	Truro
Melanoplus atlanis...........	30 June	Truro	26 Oct.	Lawrence-town, Hx. co.
Melanoplus femur-rubrum	3 July 7 July	Greenfield, Qu. Co. Truro	28 Oct.	Halifax
Melanoplus extremus.........	5 July	Truro	....	....
Chorthippus curtipennis.......	6 July 27 July	Truro Halifax	26 Oct.*	Lawrence-town, Hx. co.
Camnula pellucida	14 July	Truro	2 Oct.	Cow Bay, Hfx. Co.
Circotettix verruculatus........	16 July 18 July	Truro Halifax	18 Oct.	Halifax
Nemobius fasciatus (*vittatus*)....	17 July	Halifax	12 Nov.	Halifax
Gryllus pennsylvanicus (*neglectus*)	17 [?] July	Halifax	5 Nov.	Halifax
Ceuthophilus terrestris.........	18 July	Truro	....	....
Conocephalus fasciatus fasciatus.	18 July	Halifax	12 Sept. 13 Sept.	Halifax Truro
Melanoplus bivittatus (*femoratus*)	22 July 1 Aug.	Truro Halifax	27 Oct.	Halifax
Dissosteira carolina...........	24 July	Halifax	28 Oct.	Halifax
Scudderia pistillata............	1 Aug.	Halifax	21 Oct.	Halifax
Mecostethus gracilis...........	9 Aug.	Truro	2 Oct.	Cow Bay, Hx. Co.
Scudderia curvicauda borealis...	12 Aug.	Truro	8 Oct.	Truro
Mecostethus lineatus...........	....	....	26 Oct.	Lawrence-town, Hx. co.

The Truro dates above-mentioned were furnished by C. B. Gooderham. The first appearances at Truro are usually considerably earlier than those at Halifax; the difference, I would judge, being about a week or, in some cases perhaps ten days. At Annapolis and Yarmouth the differences would be greater. The first sign of Orthoptera hatching at Truro in 1915 was noted on 3rd June, when the tiny nymphs of *C. pellucida* and *C. verruculatus* could be seen in very warm places. Newly hatched nymphs of Crickets were observed at the same place on 5th June, 1915. Nymphs of *M. bivittatus* in the second stage have been noted at Halifax on 1st July. The young of *M. atlanis* were reported

*A single *Chorthippus curtipennis* taken at Halifax on 18 Nov., 1917, is an unusual survival, too abnormal to record in this table.

to have been seen on Sable Island. N. S., by 28 May, 1896, and it was stated that they were a month later than in 1895 (*vide* letter of Supt. R. J. Boutillier, of 28 May, 1896, referred to under *M. atlanis*).

From the foregoing table we see that the dates of the appearance of non-hibernating adults range from about 30 June (*M. atlanis*) to about 12 Aug. (*S. curvicauda borealis*), the warmest period of the year; and averages about 18 July. The autumnal disappearance of these adults ranges from about 12 Sept. (*Conocephalus fasciatus*), which is the approximate time of the first hoar-frost (13-29 Sept.), to about 12 Nov. (*Nemobius fasciatus*) which is about the time when the first snow whitens the ground (31 Oct. - 14 Nov.); and averages 19 Oct., which is about the average date of the first hard frost (16th Oct.).

Number of species in Nova Scotia.—The passing out, to the south of us, of species less northerly in range, and the paucity of strictly boreal forms, has resulted in our orthopteran fauna being a very scanty one as regards the number of species, when compared with that of regions to the south of us. This is just as would be anticipated. The present list contains 28 species (two of which are inserted hypothetically, as almost certain to occur here because they have been taken to the north and to the south of us), 18 genera (one of which is included hypothetically), 10 subfamilies, and 4 families. Of species which may possibly occur this far north, as they are found more or less commonly in Maine, I have referred to about 15 in footnotes, and of these no doubt less than 7 will ever actually be taken here; so that it may perhaps be fair to surmise that about 35 species is the utmost we can ever hope to expand our list to, and even that is probably an excessive estimate.

Now as compared with 28 species from Nova Scotia (with a possibility of something less than 35 in the future), we find that:

Hebard, for Newfoundland, in 1915, reported 6 species.

Walker, for Prince Edward Island, in 1915, reported 11 species.

Smith, for Maine, in 1869, reported 38 species.

Walker, for Ontario, in 1898-1904, reported about 87 species. (This is exclusive of *Blattidæ*. Of the latter he reported, in 1912, 11 species, only 2 of which are natives. This makes a total of about 98 species.)

Caulfield, for Canada, in 1888, reported 76 species.

Scudder, for New England, in 1900, reported 98 species.

Walden, for Connecticut, in 1911, reported 109 species.

Beutenmüller, for New York, in 1894, reported 114 species.

Blatchley, for Indiana, in 1903, reported 148 species.

Scudder, for the whole of United States and Canada, in 1901, reported 856 nominal species.

The known Orthoptera of the world has been estimated as over 10,000 nominal species.

That is, Nova Scotia has, so far as known, only about 3¼ per cent. of the species known to occur in the United States and Canada.

A numerical comparison between the Orthoptera of Nova Scotia (Piers, 1917) and of New England (Scudder, 1900), may be tabulated by Families thus:—

Families	Actual numbers		Percentages	
	Nova Scotia	New England	Nova Scotia	New England
Forficulidæ	0	2	0	2.04
Blattidæ	2	11	7.13	11.23
Phasmidæ	0	1	0	1.02
Acrididæ	17	47	60.72	47.96
Tettigoniidæ	6	23	21.43	23.47
Gryllidæ	3	14	10.72	14.28
Totals	28	98	100.00	100.00

A similar comparison of the Subfamilies of the largest Family, *Acrididæ*, gives the following result:—

Subfamilies	Actual numbers		Percentages	
	Nova Scotia	New England	Nova Scotia	New England
Acrydiinæ (Tettiginæ)..............	3	5	17.64	10.64
Acridinæ (Tryxalinæ)..............	4	9	23.53	19.15
Œdipodinæ........................	4	15	23.53	31.91
Locustinæ (Acridinæ)..............	6	18	35.30	38.30
Totals........................	17	47	100.00	100.00

We thus see how sparse our orthopteran fauna is in species, and this, as before stated, is just as might be expected considering our geographical position and climatic conditions. E. M. Walker's preliminary list of Prince Edward Island Orthoptera, consisting of 11 nominal species, is doubtless fairly well under the actual number which will yet be found there, but it is very unlikely that that list will ever go over 20 species. Regarding New Brunswick we have almost no data at present; but its species should slightly exceed in number those of Nova Scotia, owing to the much more ready passage inward of forms from the adjoining state of Maine. From Newfoundland only six species have so far been reported (Hebard, Ent. News, xxvi, p. 306, 1915).*

It may be here noted that the two species admitted to my present list on hypothetical grounds, namely *Podisma glacialis* and *Melanoplus fasciatus*, have been included because they have been reported both from Prince Edward Island on the north and from Maine to the south, and therefore it is hardly possible that they will not yet be found here in certain favourable localities. No species of more southern range only, have been thus admitted; and all references

*The species reported by Hebard from Newfoundland (G. P. Englehardt collector, Aug. 1912) are, *Chorthippus curtipennis* (Har.), *Mecostethus gracilis* (Scud.), *Circotettix verruculatus* (Kirby), *Melanoplus fasciatus* (Walk.), *Melanoplus femoratus* (Burm.), and *Ceuthophilus terrestris*, Scud.

to species which may possibly extend into this province from a more southerly range, but which have not yet been taken here or to the north of us, are placed in footnotes.

Relative abundance of Nova Scotian Orthoptera.—Although the number of our species is small, yet certain species are very numerous in individuals, and thus make up to some extent for the paucity of kinds. The relative scale of abundance I have adopted, and the approximate placing of the various species in the divisions of the scale, are about as follows; although it must be borne in mind that some species may be quite common in particular localities and yet more or less rare in others. Some seasons also affect the relative abundance.

The following table of relative abundance refers to the vicinity of Halifax, on the Atlantic coast of the province, the fauna of which belongs to the Canadian Zone:—

Excessively common.—*Nemobius fasciatus; Melanoplus femur-rubrum.*

Very common.—*Melanoplus bivittatus; Chorthippus curtipennis; Conocephalus fasciatus; Circotettix verruculatus; Scuddaria pistillata.*

Common.—*Dissosteira carolina; Gryllus pennsylvanicus neglectus; Blattella germanica* (in town houses).

Rather common.—*Blatta orientalis* (in town buildings).

Rather uncommon.—*Melanoplus atlanis* (on one occasion excessively common on Sable Island).

Rather rare.—*Mecostethus gracilis; Camnula pellucida; Scudderia furcata.*

Rare.—*Mecostethus lineatus; Nomotettix cristatus.*

Very rare.—

Hypothetical.—*Podisma glacialis; Melanoplus fasciatus.*

For comparison with this, C. B. Gooderham has furnished, at my request, the following similar table of relative abundance of species about Truro, Col. Co., which may be taken as

fairly representative of the western section of the province, the fauna of which belongs to the Alleghanian Division of the Transition Zone:—

Excessively common.—*Gryllus pennsylvanicus neglectus; Nemobius fasciatus; Chorthippus curtipennis; Camnula pellucida* (during some years at least).

Very common.—*Melanoplus atlanis; Circotettix verruculatus; Melanoplus bivittatus; Conocephalus fasciatus.*

Common.—*Melanoplus femur-rubrum; Dissosteira carolina; Acrydium arenosum angustum*; *Mecostethus gracilis.*

Rather common.—*Scudderia pistillata; Scudderia curvicauda borealis; Nomotettix cristatus; Acrydium granulatum.*

Rather uncommon.—

Rather rare.—

Rare.—*Blattella germanica; Melanoplus extremus.*

Very rare.—*Ceuthophilus maculatus; Ceuthophilus terrestris; Nemobius carolinus.*

Commonest species.—The nine most prevalent species, all of which anyone is certain to note during a single walk about the outskirts of Halifax in late summer or early autumn, are the following: *Nemobius fasciatus* and *Melanoplus femur-rubrum* in every pasture; *Melanoplus bivittatus* in the long grass of meadows and the rank-growing vegetation about the edges of fields; *Chorthippus curtipennis* about vegetation along fences, etc.; *Conocephalus fasciatus* in long grass in damp places; *Circotettix verruculatus* and *Dissosteira carolina* on hot, dusty roadsides, railways, and stony places generally; *Gryllus pennsylvanicus neglectus* on stone-strewn earthy slopes about roadsides, etc.; and *Scudderia pistillata* on alders and occasionally other small bushes about damp places and the edges of clearings. The last-named species will probably only come to notice through its loud rasping calls heard mostly at evening and night.

Common names.—For insects which are so abundant, so much in evidence about cultivated districts, and so detrimental to agriculture, it is very remarkable that hardly any species has a distinctive popular name applied to it by ordinary people. The English names assigned to many of the species in works on the Orthoptera, are almost invariably mere appropriate "book-names", which it is hoped will be adopted by readers and so gradually become current. This, however, has not yet taken place. Ordinary people in Nova Scotia distinguish, of course, the two species of Cockroach, and speak in very general terms of "grasshoppers" and "crickets", and country children occasionally call a locust or grasshopper a "molasses bug", because of the brownish salivary fluid it ejects from the mouth when handled, and this name perhaps more specially applies to the familiar *Melanoplus bivittatus*. The only true local name, however, which I have heard specifically applied to our many native species, is the very appropriate one of "Cracker", or less often "Snapper", for the familiar roadside species, *Circotettix verruculatus*; the first-mentioned name being pretty general among country people throughout the province, and one well worthy of general adoption.

Remarks on the present list.—My previous annotated list of fourteen species, published in 1896, was made up solely of such forms as I had myself collected, almost entirely about Halifax, in the seasons of 1895 and 1896. At that time Francis Walker's unreliable lists of 1869-72 (see bibliography) were the only other existing contributions to a knowledge of our local Orthoptera, and they were of such a character that it was considered advisable to disregard them. In the present paper I have revised the nomenclature so as to bring it up to date, have made full use of all available sources of information, including C. B. Gooderham's valuable notes from the western part of the province, and have incorporated many additional observations of my own. Subspeci-

fic names, when at all in use, are noted, but this in a very subsidiary way when they are founded on mere trivial distinctions between intergrading long- and short-winged forms. Other trinomial names, as in the case of well defined geographical races, are of course accepted. It is perhaps well, in a local paper like this, to as clearly as possible designate in all cases just what particular form or variant is found here. Some may possibly criticize any prominence whatever given to dimorphic forms through the use, even very subordinately, of special names to distinguish their various phases; but their occasional use helps towards preciseness and at least cannot lead to confusion. Appended to the scientific name, is the name of the original describer of the species, his name being printed in parentheses when the species is now placed in a different genus from that to which it was first assigned by that authority. Following the scientific name and the so-called "common name", which as we have seen is usually not a common name at all, appear references to the names used by writers in papers dealing with Nova Scotian Orthoptera in any way. These latter articles are such as may be called original sources of information as far as this province is concerned. No attempt has been made to present a general synonymy of the species, which may be seen in the writings of authors such as Blatchley and Scudder.*

As one has frequently to go from one monograph to another to get descriptions of all our species, which is always laborious and in fact impossible for many who have not such literature at hand, and as I strongly believe that this difficulty which besets a beginner is one of the very reasons why we have given so little attention to this highly important order

*Beginners may be reminded that names of families end in *-idæ* and those of subfamilies in *-inæ*. It will aid the student in pronouncing these names to know that the *i* in *-idæ* in family names is short, and therefore the accent falls on the syllable preceding that letter; while the *i* of *-inæ* in subfamily names is long and consequently accented.

of destructive insects, I have given descriptions of all the species, the structural portions being usually modified from various writers, while the descriptions of colour, which varies much more than structure, have in almost every instance been prepared anew directly from Nova Scotian specimens. The colour terms used are those of Ridgway's "Nomenclature of Colors," 1886. Measurements have either been adopted from other writers, or made from local specimens when considered more advisable, in which latter case it is so stated. The particulars as to geographic range have mostly been compiled anew, with considerable labour, from very many articles, as recent writers have extended or modified the range as formerly known.

Under the heading of "Occurrence in Nova Scotia" will be found all that more particularly relates to the species as found here. The subject-matter of these local notes on each species is arranged thus, although without actual distinctive headings: (1) By whom first reported from Nova Scotia and when; (2) abundance; (3) particular localities reported from; (4) habitat or natural haunt; (5) seasonal dates of occurrence; (6) habits and call-notes; (7) economics, destruction caused and preventive measures. Analytical keys have been given to assist in identification, and these have been modified from various writers to suit our local requirements, the publications of Prof. Blatchley, B. H. Walden, Dr. Scudder, and others being largely drawn upon for the purpose. Very brief descriptions of species which might occur here, because of their commonness in the state of Maine, are placed in footnotes, and no doubt they will prove helpful when unrecorded species are met with. They will also serve to stimulate students to search for such additional forms.

Measurements are given in millimetres, about 25.4 of which equal one inch. The length of body is taken from the fastigium or apex of the head to the apex or end of the

subgenital plate (that is, the extremity of the under portion of the last abdominal segment) in both sexes. It thus does not include such appendages as the ovipositor, anal bristles, or antennæ. The length of the ovipositor is taken from the ventral apex of the basal plica, or fold, to the extremity of the ovipositor. In making careful measurements it will be found most convenient to use fine spring dividers with screw adjustment, operated by a milled wheel between the legs of the instrument, which wheel is easily turned by one of the fingers. Strong hand lenses, and on rare occasions a compound microscope, are required for examining specimens in detail; but for general examination and for use when making measurements, I find by far the most convenient arrangement is an ordinary spectacle lens, of three inches focus, or stronger if desired, mounted in the right-hand side of a common spectacle frame, which may be very cheaply obtained at any optician's. This leaves both hands entirely free for manipulation, which is a very great convenience; and the left eye may be used for normal vision when desired. Such a lens I have found of the very greatest service in much general biological work, whenever it is necessary to use both hands and a low-power glass is suitable. Strange to say, I have never found this simple and remarkably convenient device mentioned by any writer.

Desiderata.—We require further data regarding the occurrence and abundance of species in Cape Breton Island, regarding which too little is yet known. Until fuller information on these points is available, we will not be able to deal as definitively as we would wish with the Orthoptera of Nova Scotia as a whole, for very likely a few species do not extend their range into the northern portions of that island. However, this is merely a matter bearing on local distribution and relative abundance, for it is not likely that unrecorded species will be found in that region. These we would rather expect from our southern and western districts. The high-

lands of the Cobequid and North Mountains might also repay investigation. More information is desired regarding the time of hatching of various species in Nova Scotia, as we have very little data on that subject. I have already referred to the need of a detailed delineation of the boundaries of our life zones, and this is a matter which interests every biologist.

Acknowledgments.—Finally, I wish to acknowledge particular indebtedness to Mr. Charles Benjamin Gooderham, B. S. A., late assistant entomologist, Agricultural College, Truro, N. S., who since 1913 has made a study of our Orthoptera, for very many notes with which he has furnished me, they more particularly relating to the western section of the province, in which I have had fewer opportunities for collecting.* To the writings of the late Dr. S. H. Scudder, Prof. W. S. Blatchley, B. H. Walden, and many others whose names will be mentioned from time to time in the text, I am also under obligations. Dr. Scudder, in the generous manner which characterized that delightful personage, verified my determinations of nearly all my earlier species of 1895-6. His death on 17th May, 1911, removed the most prominent figure in North American orthopterology. Mr. James A. G. Rehn of the Academy of Natural Sciences, Philadelphia, and Dr. E. M. Walker of the University of Toronto, have kindly answered various enquiries.

*Mr. Gooderham has very recently been transferred to the Central Experimental Farm, Ottawa, as assistant to the Dominion Apiarist, Bee Division.

PART 2.—SYSTEMATIC DESCRIPTION OF NOVA SCOTIAN ORTHOPTERA.

REFERENCE LIST OF SPECIES.

Order ORTHOPTERA.

Suborder NON-SALTATORIA (Non-leaping Orthoptera).

Family BLATTIDÆ (Cockroaches).

Subfamily **Pseudomopinæ** (Cockroaches, in part).

1. *Blattella germanica* (Linnæus). Croton Bug; German Cockroach; "Yankee Settler."

Subfamily **Blattinæ** (Cockroaches, in part).

2. *Blatta orientalis* Linnæus. Oriental Cockroach; Black Beetle.

Suborder SALTATORIA (Leaping Orthoptera).

Family ACRIDIDÆ (Short-horned Locusts).

Subfamily **Acrydiinæ** (Grouse Locusts).

Group Tettigiæ.

3. *Nomotettix cristatus* (Scudder). Crested Grouse-locust. (Short-pronotumed form).
4. *Acrydium granulatum* Kirby. Slender Grouse-locust. (Long-pronotumed form).
5. *Acrydium arenosum angustum* (Hancock). (Short-pronotumed form).

Subfamily **Acridinæ** (Oblique-faced Spineless Locusts).

Group Orphulæ.

6. ? *Orphulella speciosa* (Scudder). [Very doubtful].

Group Stenobothri.

7. *Chorthippus curtipennis* (Harris). Short-winged Brown Locust.

Group Epacromiæ.

8. *Mecostethus lineatus* (Scudder).
9. *Mecostethus gracilis* (Scudder).

Subfamily **Œdipodinæ** (Vertical-faced Spineless Locusts).

Group Œdipodini.

10. *Camnula pellucida* (Scudder). Clear-winged Locust.
11. *Hippiscus apiculatus* (Harris). Coral-winged Locust.
12. *Dissosteira carolina* (Linnæus). Carolina Locust.
13. *Circotettix verruculatus* (Kirby). "Cracker".

Subfamily **Locustinæ** (Spine-breasted Locusts).
Group Melanopli.

14. [*Podisma glacialis* (Scudder). Hypothetical occurrence.]
15. *Melanoplus atlanis* (Riley). Lesser Migratory Locust.
16. [*Melanoplus fasciatus* (Barnston-Walker). Hypothetical occurrence.]
17. *Melanoplus femur-rubrum* (DeGeer). Red-legged Locust.
18. *Melanoplus extremus* (F. Walker). (Short-winged form.)
19. *Melanoplus bivittatus* (Say). Yellow-striped Locust. (Red-legged phase, sometimes called *M. bivittatus femoratus* [Burmeister]).

Family TETTIGONIIDÆ (Long-horned Locusts).

Subfamily **Phaneropterinæ** (Katydids, in part).
Group Scudderiæ.

20. *Scudderia pistillata* Brunner. Northern Katydid.
21. *Scudderia curvicauda borealis* Rehn & Hebard. Broad-winged Curved-tailed Katydid.
22. *Scudderia furcata furcata* Brunner. Northern Fork-tailed Katydid.

Subfamily **Conocephalinæ** (Cone-headed and Meadow Grasshoppers).
Group Xiphidiini.

23. *Conocephalus fasciatus fasciatus* (DeGeer). Eastern Slender Meadow Grasshopper.

Subfamily **Stenopelmatinæ** (Stone and Camel Crickets).
Group Ceuthophili.

24. *Ceuthophilus maculatus* (Harris). Spotted Camel Cricket.
25. *Ceuthophilus terrestris* Scudder.

Family GRYLLIDÆ (Crickets).

Subfamily **Gryllinæ** (Ground and Field Crickets).

26. *Nemobius fasciatus* (DeGeer). Striped Ground Cricket. (Short-winged form, sometimes called *N. fasciatus vittatus* [Harris].)
27. *Nemobius carolinus* Scudder. Carolina Ground Cricket.
28. *Gryllus pennsylvanicus* Burmeister. Pennsylvanian Field Cricket. (Shortest-winged form, sometimes called *G. pennsylvanicus neglectus* Scudder.)

Order ORTHOPTERA.

(Cockroaches, Locusts, Grasshoppers, Crickets, etc.)

The Orthoptera are insects with incomplete metamorphosis (group *Heterometabola*). The young, when hatched from the egg, are entirely wingless, but of the general form of the adult. They moult their skin five times as they grow, and the wings gradually develop, there being no well defined separation between the larval and pupal stages as in other orders of insects. The young in all stages are known as "nymphs"; but when they emerge from the final moult as perfect insects, they are called "imagos". The mouth-parts project and are fitted for biting. Wings, when present, four in number; the first pair membranous or leathery and usually with many veins, thicker than the hind wings which are folded lengthwise like a fan (whence the name of the order, from *orthos*, straight, and *pteron*, a wing). The wings of a few species are absent, while others have only the wing-covers present. If wings are absent, the labium (lower lip) is cleft. Nearly all Orthoptera are vegetable feeders and injurious, some species doing immense damage.

Key to Suborders of Orthoptera.

a. Legs of nearly equal size, the hind femora not enlarged for leaping; sound-producing organs absent; wing-covers and wings of nymphs (immature insects), when present, in normal position; ovipositor concealed......... NON-SALTATORIA, p. 245.

aa. Legs of unequal size, the hind femora thickened for leaping, usually much longer than middle femora; sound-producing organs usually present in males; wing-covers and wings of nymphs, when present, in a reversed position (as if they were upside down and with the rudimentary wing-covers inside the wings); ovipositor usually plainly visible.......... SALTATORIA, p. 251.

Suborder NON-SALTATORIA (Non-leaping Orthoptera).

(For characteristics see key just given).

Recent writers have placed the family *Forficulidæ* (Earwigs) in a new order, *Euplexoptera*, entirely distinct from the Orthoptera, with which it was formerly united, as they differ somewhat radically from the members of the latter order. The *Forficulidæ* have a short, narrow body; head

with mouth in front; wing-covers leathery, very short, and without veins; tarsi five-jointed; the abdomen ending in a horny, forceps-like appendage. No species of the *Forficulidæ* are known to occur in Nova Scotia, although *Labia minor* (Linnæus), the Little Earwig, coloured black and yellowish-brown, with last abdominal segment and forceps reddish-brown, and about 5 mm. long, may yet be detected here, as it is the most northern species and occurs in the United States and Canada east of the Rocky Mountains, as far north as Maine, New Hampshire, Vermont, Quebec and Ottawa. It might easily have been overlooked by our collectors. Joseph Perrin of McNab's Island, Halifax Harbour, informs me that he was familiar with it in England, and thinks he saw several in the spring some years ago about his garden on that island; but he preserved no specimens and consequently it is merely a matter of opinion. According to his recollection the insects he saw were about half an inch in total length, which would be too long for the total maximum length (8 mm.) of this species. C. B. Gooderham, of Truro, has never seen or heard of the species in the western part of Nova Scotia.

No species of the family *Mantidæ* (Praying Mantids) occur even as far north as the New England States; and of the *Phasmidæ* (Walking-sticks), *Diapheromera femorata* (Say) has been taken commonly in most of the New England States, but not in Maine, and therefore cannot be expected to extend into Nova Scotia.

Family BLATTIDÆ (Cockroaches).

Head almost concealed beneath pronotum; body short, broad, oval and flattened; pronotum shield-shaped; wing-covers usually parchment-like or leathery and thickly veined; abdomen ending in cerci, but these not distinctly forceps-like; tarsi five-jointed.* Only introduced species are known to occur in Nova Scotia.

*There has just appeared a thorough revision of this family by Morgan Hebard, entitled "The Blattidæ of North America, north of the Mexican Boundary," Memoirs of Am. Ent. Soc., No. 2, Phila., 1917, 284 pp., 10 plates.

KEY TO SUBFAMILIES OF BLATTIDÆ.

a. Last ventral segment of female abdomen plane, without a ridge and undivided; fore femora rarely armed beneath on inner margin with many spines; when so armed, the subgenital styles unequal or wanting. PSEUDOMOPINÆ, p. 247.

aa. Last ventral segment of female compressed so as to form a ridge on its under side, and divided so as to be bivalved; fore femora armed beneath on inner margin with many spines................ BLATTINÆ, p. 249.

Subfamily **Pseudomopinæ** (Cockroaches, in part).

(*Blattellinæ* of former writers.)

So far only a single representative of a single genus, *Blattella*, and that an introduced species, has been found in Nova Scotia. Another large North American species, *Ischnoptera pennsylvanica* (De Geer), the female of which is believed to be what has been called *Phyllodromia borealis* (Saussure), has been reported under the latter name from Maine and Massachusetts, and under the former name from Ontario, and possibly, but not at all likely, may occur here. The males and females of this species are so unlike that many have considered them to be separate species.

1. **Blattella germanica** (Linnæus). CROTON BUG; GERMAN COCKROACH; "YANKEE SETTLER" (local name in Nova Scotia).

Phyllodromia germanica. Piers, Trans. N. S. Inst. Sc., ix, 209 (1896); Halifax.

Description.—Size small; body rather long, sides slightly narrowing in male and almost parallel in female; wing-covers fully developed in both sexes, membranous or somewhat leathery, as long or longer than abdomen in both male and female; subanal plate of male with styles rudimentary or wanting.

Colour.—Yellowish-brown, females often darker; legs lighter; pronotum with two dark brown longitudinal stripes separated by one of yellowish.

Measurements.—Male: body, 13 mm.; width of body, 4 mm.; antennæ, 14 mm.; wing-covers, 9-10 mm. Female: body, 10 mm.; antennæ, 13 mm.; wing-covers, 11 mm.

Range.—Native of Europe; introduced into America where it has spread abundantly almost everywhere, especially in dwellings in towns, although seldom found in numbers in country districts. It made its appearance in New York in numbers about 1842 when the Croton aqueduct was completed, and hence is often called the Croton Bug.

Occurrence in Nova Scotia.—When this troublesome insect first appeared in Nova Scotia, there is no data to show, as it was not reported from here by scientific writers until

1896. Walker did not include it in his list of Canadian Orthoptera of 1872, but the Nova Scotian references in that catalogue were founded on collections made here by Lieut. Redman prior to 1848, and probably about 1821. The common name, "Yankee Settler," which is usually applied to it in Halifax, shows that in the popular mind at least it was believed to have been an incomer from the New England states.

It is very common in some houses in Halifax and doubtless occurs also, but less commonly, in other large shipping towns in the province. C. B. Gooderham has taken it only once at Truro, Col. Co. where he reports it rare. I am also informed that it occurs in Oxford, Cumb. Co. It is very rarely, if ever, seen in the country districts. It is less often found in dirty surroundings than the larger Oriental Cockroach (*B. orientalis*), and therefore is more liable to be met with in the better class of dwellings. It delights in warm, moist places, such as the vicinity of fire-places and hot-water pipes, and is less strictly nocturnal than the Oriental Cockroach. When it has once gained an entrance, it is extremely difficult to exterminate, as its small size and flat body permit it to hide and breed in small cracks where the larger cockroach could not penetrate. The rapidity with which it propagates also adds to its seriousness as a household pest in cities.

It is careful to avoid poisoned food placed to tempt it. A most thoroughly effective means of ridding premises of this pest, is fumigation with hydrocyanic gas. This gas, however, is extremely poisonous to human beings, and its use by inexperienced persons should never be thought of. Fumigation with a poisonous gas such as bisulphide of carbon is somewhat more suitable and quite effective when rooms or ship's holds can be vacated and sealed up, and the liquid exposed therein in open vessels at the rate of one pound to every 1,000 cubic feet of room space. When left for twenty-four hours all roaches and every other kind of vermin will be

destroyed. As it is also poisonous to higher animals, the building should be vacated during the fumigation, and afterwards very thoroughly aired before re-occupation. It must be borne in mind that bisulphide of carbon is violently explosive in presence of fire, and the very greatest precaution should be taken that no fires or lights whatever are about the premises until after they are thoroughly freed of every trace of gas. The fumigation had better be done, in any case, only by experienced persons. When possible, superheating is a comparatively simple and very effective means of destroying cockroaches as well as other household insects. Cockroaches cannot withstand a temperature of 120° F. for more than a few minutes, and the maintenance of a temperature of from 150° to 160° F. for several hours should result in killing every insect in a building. Sodium fluoride, pure or mixed with equal parts of plaster-of-paris, strewn about the haunts, is a simple and very effective means of control. Temporary relief from the roaches may be gained by the liberal use of fresh pyrethrum powder (Persian insect powder), which is quite safe. The dead and paralyzed roaches may afterwards be swept up. Flowers-of-sulphur is also a good repellant. (For other information on this subject, see L. O. Howard's circular No. 46, 2nd series, U. S. Dept. of Entomology, Wash.; also E. P. Felt's "Household and Camp Insects", bulletin No. 194, N. Y. State Museum, Albany, 1917.)

Subfamily **Blattinæ** (Cockroaches, in part).

(*Periplanetinæ* of former writers.)

Wing-covers and wings variable in different species; last ventral segment of female compressed so as to form a ridge on its under side, and divided so as to be bivalved; fore femora armed beneath on inner margin with many spines; subgenital styles of equal length.—This subfamily contains our larger cockroach, an introduced species like the one last mentioned.

2. **Blatta orientalis** Linnæus. ORIENTAL COCKROACH; BLACK BEETLE; "COMMON COCKROACH".

Stylopyga orientalis. Piers, Trans. N. S. Inst. Sc., ix, 210 (1896); Halifax.

Description.—Size rather large, male shorter and narrower than female; distance between eyes less than length of last joint of maxillary palpus; wing-covers of neither sex reaching end of abdomen, but fairly well developed and covering about three-quarters of abdomen in male, and rudimentary and covering about one-third in female.

Colour.—Dark, mahogany-brown; legs and underside of body somewhat lighter; pronotum without light margin or other markings.

Measurements.—Male: body, 22 mm.; length of pronotum, 5.5 mm.; width of pronotum, 7.5 mm.; wing-covers, 13-14 mm. Female: body, 27 mm.; length of pronotum, 6.5 mm.; width pronotum, 8.5 mm.; wing-covers, 5 mm.

Range.—A native of Asia, carried by shipping from one country to another until it has become cosmopolitan. Found over the most of America, especially in city dwellings by the seaboard.

Occurrence in Nova Scotia.—This large noxious cockroach was doubtless introduced into Nova Scotian ports by shipping at a very early period in our history, although not actually recorded scientifically until recent years. Without doubt it is the cockroach mentioned by Walter Bromley in his "General Description of Nova Scotia", 1825, page 33. It is common in some houses in the older parts of Halifax, and doubtless also in other large shipping towns along our coast, but in the country districts it seems to be very rarely met with. C. B. Gooderham has not so far found it at Truro, Col. Co., or along the Bay of Fundy, although he has heard of its occurrence. When once it gains a foothold in a dwelling it is liable to become one of the most disgusting and troublesome of household pests, and one rather difficult to get rid of in spite of persistent efforts to exterminate the pest. It is nocturnal in habit and devours almost anything. Unlike the German Cockroach or Croton Bug, it delights in dampness, dirt and darkness, its favourite habitat being the holds of vessels, cellars and basements. Despite its abundance, it develops slowly, as from three to five months are required to arrive at maturity.

Its large size makes it easier to exterminate than the German Cockroach, as it cannot hide in narrow crevices. The remedies noted under that insect, may also be used against this species; but simpler ones are likewise employed. A deep jar, partially filled with stale beer or ale, with a number of sticks placed against it and bent over so as to project into the interior for a few inches, may be used as an effective trap. The roaches climb up the sloping sticks to get the beer, and then slip off into the jar. Another household remedy is a saucer containing a dry mixture of plaster-of-paris with three or four parts of flour, and another plate containing water, placed near, with bridges to give easy access, and one or two pieces of wood floating on the water and touching the margin. The insects eat the dry mixture, then go to the water and drink, whereupon the plaster sets within them and causes death. Our bakers say they largely employ powdered borax for keeping them in check, the borax being sprinkled about infested places. As they detest and avoid light, the introduction and continual burning of electric lights in our city bakeries has done much to rid them of the pests. Infested places should always be kept clean, dry, and light.*

Suborder SALTATORIA (Leaping Orthoptera).

Legs of unequal size; hind femora adapted for leaping, being much thickened. Sound-producing organs usually present in male. Wing-covers and wings of nymphs, when present, in a reversed position.

KEY TO FAMILIES OF SALTATORIA.

a. Antennæ much shorter than body; tarsi 3-jointed; calling organs, when present, usually on hind femora and lower border of wing-covers; ovipositor of two pairs of short plates, with tips diverging. . . . . (Short-horned Locusts) ACRIDIDÆ. p. 252.

*_Periplaneta americana_ (Linnæus), the American Cockroach, a large species which is a native of tropical America but has become cosmopolitan, is common along the seaboard of New England, especially in city buildings and warehouses, and quite likely will be found introduced by shipping into some of our waterside storehouses. The length of body is 27 mm. in male, and 30 mm. in female, and the wing-covers in both sexes are large, extending 10-12 mm. beyond the end of abdomen. The general colour is reddish brown, the pronotum margined with yellow. It belongs to the subfamily _Blattinæ_. It is probably the large cockroach which is said to be sometimes brought to Halifax with cargoes of sugar from the West Indies, and may have insinuated itself into some of the warehouses of our sugar refineries. Other southern species are liable to be casually introduced with bunches of bananas.

aa. Antennæ much longer than body; tarsi 3- or 4-jointed; calling organs, when present, on dorsal area of wing-covers; ovipositor usually much elongated.

b. Tarsi 4-jointed; wing-covers with sides sloping; ovipositor usually flattened, sword-shaped...... (Long-horned Locusts) TETTIGONIIDÆ.

bb. Tarsi 3-jointed; wing-covers flat above, with sides bent abruptly down; ovipositor a nearly straight or upcurved needle.......... (Crickets) GRYLLIDÆ.

Family ACRIDIDÆ (Short-horned Locusts).

This family is readily distinguished by the antennæ, which are much shorter than the body. The species are usually simply called "grasshoppers", no attempt being made by the ordinary individual to apply special names to the many species. The males only, as in other Orthoptera, have stridulating or sound-producing organs. In the subfamilies *Locustinæ* (Spined Locusts) and *Acridinæ* (Oblique-faced Spineless Locusts) this call-note is produced by rubbing the inner surface of the minutely-toothed hind femora, over veins of the wing-covers, this being done when the insect is otherwise at rest. In the subfamily *Œdipodinæ* sound is usually produced while in flight, by rubbing together the upper surface of the front edge of the wings and the under surface of the wing-cover, thus producing a sharp, cracking sound, which is very familiar in the case of *C. verruculatus*.

The *Acrididæ*, with the exception of the members of the hibernating subfamily *Acrydiinæ*, pass the winter in the egg stage; the eggs, 30 to 60 in number, being deposited during the autumn, usually in a hole which the female forms in the ground, the cavity being then covered with earth. If the succeeding winter is an open one with many changes of temperature, many eggs are destroyed. Next season the young hatch and are at first wingless. Five times the nymph moults its skin, the wings and body increasing in size each time, and after the fifth moult it emerges a mature insect or imago.

KEY TO SUBFAMILIES OF ACRIDIDÆ.

a. Size very small; *pronotum extending backward*, tapering, to or beyond end of abdomen; wing-covers represented by small oval lobes on sides. (Grouse Locusts) ACRYDIINÆ. p. 253.

aa. Larger; *pronotum not extending over abdomen:* wing-covers usually well developed, but sometimes abbreviated or even wanting.

b. *No spine on prosternum* between front legs.

c. Face usually very oblique; medium carina of pronotum never raised as a crest, or cut by more than one notch.............
(Oblique-faced Spineless Locusts) ACRIDINÆ. p. 263.

cc. Face nearly or quite vertical; median carina of pronotum usually raised as a crest and usually cut by more than one notch.
(Vertical-faced Spineless Locusts) ŒDIPODINÆ, p. 273.

bb. *A prominent conical spine on prosternum* between front legs.......
(Spine-breasted Locusts) LOCUSTINÆ. p. —.

Subfamily **Acrydiinæ*** (Grouse Locusts).

(*Tettiginæ* of former writers.)

The members of this subfamily are our smallest Acridians, and are easily recognized by the pronotum which extends to or beyond the end of the abdomen. Most, if not all, of the species are dimorphic as regards length of pronotum and hind wings. Wings are usually developed; but the wing-covers are rudimentary (small lobes near base of wings), what looks like them being an unusual development of pronotum. Males are usually narrower than females. Individuals of a species vary much in colour and markings, which must not be taken as diagnostic. Grouse Locusts are remarkable as being the only members of the *Acrididæ* which normally pass the winter as adults, hibernating under rubbish, loose bark, fence-rails, etc., and are therefore the first Orthoptera to appear in the spring, being seen on sunny hillsides in Nova Scotia as early as the middle of April. The eggs are laid in ground early in the season, and hatch in about three weeks, and the young usually reach maturity by autumn. They are very inconspicuous insects, as their colour harmonizes with the surroundings. Dry sunny hillsides or boggy places along lakes and streams are favourite habitats. Their food consists of vegetable mould, tender sprouting grass, and

*The application of such very similar names as *Acrydiinæ* and *Acridinæ* to two subfamilies of the family *Acrididæ*, which have lately been known as the *Tettiginæ* and *Tryxalinæ*, is a most confusing contretemps, but as J. A. G. Rehn says, there is apparently no escape from this unhappy situation. *Acrydium* (Geoffr., 1762) is a far older name for the genus which has usually been called *Tetrix* (Latreille, 1802) or *Tettix* (Charpentier, 1841), and *Acrida* (Linn., 1758) is the oldest known genus of the group that has been termed *Truxalinæ* or *Tryxalinæ* (Genus *Truxalis*, Fabricius, 1775).

germinating seeds. Despite the similarity of the name of this subfamily with that of the *Acridinæ*, the beginner must be careful to discriminate between the two names (see footnote or preceding page).

The use of trinomial names, such as *Acrydium ornatum ornatum* and *A. ornatum triangulare*, to distinguish the so-called long- and short-winged extreme phases of dimorphic species such as often occur in this subfamily, is discouraged by late writers, as being of but little if any real value, as the two extreme forms intergrade and interbreed. This is evident to those who have examined a large series of specimens from many regions or even from one locality.

KEY TO NOVA SCOTIAN GENERA OF ACRYDIINÆ (GROUSE LOCUSTS).

a. Antennæ 12—13-jointed; median carina of pronotum high and crest-like, arched longitudinally; upper lateral sinus of pronotum about half as deep as lower one............................NOMOTETTIX. p. 254.

aa. Antennæ usually 14-jointed; median carina of pronotum low and rather flat when viewed from side; upper lateral sinus of pronotum nearly as deep as lower one..............................ACRYDIUM. p. 256.

Group Tettigiæ.

3. **Nomotettix cristatus** (Scudder). CRESTED GROUSE-LOCUST. (Short-pronotumed form.)

Nomotettix cristatus. Gooderham, Proc. Ent. Soc. N. S. for 1916, 23, 27 (1917); Colchester Co.

Description.—Nova Scotian specimen. This is the smallest of our Orthoptera, and may be readily recognized by the high arched pronotum, or bowed outline of the dorsal line when viewed from the side. Body finely granulate, most noticeable on pronotum. Antennæ of 12-13 joints. Vertex .8 mm. wide, projecting beyond eyes, the front margin rounded when seen from above, and anterior end of median carina forming a small median projection; pronotum with the front margin produced in an angle over back of head to posterior quarter of eye; median carina raised as a high crest and arched lengthwise for about three-fourths its length, then sloping down and more nearly horizontal near apex; upper notch or sinus on hind margin of lateral lobe of pronotum very shallow, less than half as deep as lower sinus; pronotum reaching to apex of hind femora (abbreviated form, sometimes called *C. cristatus cristatus**); front femora more or less compressed, carinate above.

Colour.—Nova Scotian specimen. Grayish fuscous-brown, slightly lighter below posterior lateral carina of pronotum and on hind tibia, the dark colour continuing for a short distance below knee; on each side of disk of pronotum are two irregularly shaped black marks enclosing a small gray

*The long-pronotumed form, sometimes called *N. cristatus carinatus* (Scudder), in which the pronotum is further elongated by a couple of millimeters, has not been found in Nova Scotia.

area, the anterior mark being 3 mm. behind the vertex and the posterior one 4½ mm.; elsewhere on pronotum are small, obscure, blackish dots; and on upper outer side of hind femora are three obscure, blackish diagonal bands. (The colour and markings, as in other related species, are subject to considerable variation.)

Measurements.—Nova Scotian specimen. Female: body, 8.25 mm.; greatest depth of body, 3.4 mm.; antennæ, 2.7 mm.; width of vertex, .8 mm.; length of pronotum, 8.7 mm.; anterior width of pronotum, 2.0 mm.; greatest width at shoulders, 3.7 mm.; greatest width of disk, 2.7 mm.; hind femora 5.5 mm.; width of hind femora, 2.1 mm.; hind tibiæ, 4.2 mm.; ovipositor, 1.0 mm.

Range.—Eastern United States and southeastern Canada: Nova Scotia, Toronto (Ont.), Maine, and south through New Eng. (common locally), to New Jers. and North Carol. at least.

Occurrence in Nova Scotia.—This very small and inconspicuous species, a hump-backed midget and the smallest Orthopteran found in Nova Scotia, was not reported in my paper of 1896. The only specimen so far taken about Halifax and the first collected in the province, is a female which I obtained on a sunny, stony path, alongside of the seashore, on the southern side of Dead Man's Island Cove, close to Melville Island, at the head of the North West Arm, near Halifax, on 7 August, 1897. As it is the only specimen I have taken, it is doubtless rare in this locality, although it may be less scarce in some particular localities. About Truro, Col. Co., it is rather common, and C. B. Gooderham has a number of specimens, taken by himself at that place, on 5 and 31 July, and 20 Aug., 1913; 5 July, 1914; and 22 June, 1915; and in the Agricultural College is one also taken at Truro on 18 July, 1913. Mr. Gooderham has observed it as early as 15 April, 1917, just as the grass was beginning to sprout, and he took five specimens on 22 April of that year. He reports it as apparently very abundant at Truro during that spring. As this species, as well as other members of the subfamily of Grouse Locusts, hibernates as a perfect insect, it may be expected to occur from April until autumn. So far it has only been reported from Halifax and Colchester counties.

The Halifax and Truro specimens are all of the abbreviated form, *N. cristatus cristatus*, with the pronotum extending no further backward than about the end of the femora.

Dr. E. M. Walker of Toronto and Mr. J. A G. Rehn of Philadelphia confirm the determination of these specimens. The extended form, sometimes designated *N. cristatus carinatus* Scudder, in which the pronotum is further prolonged (measuring 9.8-11.5 mm. in male, and 9.5-10.7 mm. in female), has not so far been met with in Nova Scotia. The species has, I believe, only once before been reported from Canada, Caulfield having taken it (*Batrachidea cristata*) at Toronto, Ont. (Can. Rec. Sc., ii, 402, 1887). Bayard Long did not observe it on Prince Edward Island, so that this may be the northern limit of its range.

It is an active little species, jumping vigorously with its thick hind femora, as one will find out on attempting to capture it; and its very small size and inconspicuous colour when on the ground, make it extremely difficult to detect and capture. It appears, like allied species, to frequent dry, sandy soil, lightly covered with fine debris, and dry sunny banks in scant pastures. In New England, where it is locally common, it is found, according to Morse, on light soils, but especially in dry pastures.

KEY TO NOVA SCOTIAN SPECIES OF ACRYDIUM.

(*A. ornatum* is included for comparative purposes and because it is liable to occur.)

Median carina of pronotum low, its dorsal outline rather flat when viewed from side; upper lateral sinus of pronotum nearly as deep as lower one (*Acrydium*).

a. Median carina of pronotum more or less distinctly elevated along entire length; dorsal surfaces of pronotum higher in middle, sloping on sides.

b. Body very slender, especially in male; front margin of vertex obtusely angulate when viewed from above, its median carina not projecting or only very slightly; hind part of pronotum long-drawn-out, its apex narrowly acute, in extended form surpassing hind femora and in extralimital abbreviated form reaching near their end................4. *granulatum*. p. 257.

[bb. Body more robust; front margin of vertex rounded, its median carina distinctly projecting; apex of pronotum in extended form considerably surpassing hind femora and in abbreviated form (*triangulare*) reaching about their end.............*ornatus* (See nomenclatural remarks under *arenosum angustum*).]

aa. Median carina of pronotum indistinct, a little elevated on its anterior third; dorsal surface of pronotum flat or nearly so; body rather robust in abbreviated form; front margin of vertex very slightly

rounded, its median carina projecting very slightly; apex of pronotum in extralimital extended from reaching considerably beyond hind femora, and in abbreviated form reaching only very little beyond them............................5. *arenosum angustum*, p. 259.

Supposing that only two species occur in Nova Scotia, beginners may roughly separate them as follows; but too much dependence must not be placed on these distinctions, in case other forms should occur here.

a. Front margin of vertex, viewed from above, distinctly but obtusely angulate.....................................4. *granulatum*.

aa. Front margin of vertex very slightly rounded....5. *arenosum angustum*.

4. **Acrydium granulatum** Kirby. SLENDER GROUSE-LOCUST. (Long-pronotumed form.)

Acrydium granulatum. Goodcrham, Proc. Ent. Soc. N. S. for 1916, 23, 27 (1917); Col., Kings, Hants, Ann., and Yar. Cos.

Description.—Form very slender, especially in male. Front of vertex, viewed from above, projecting forward considerably in a *distinct but obtuse angle*, its median carina projecting but little if any beyond sides; pronotum almost truncate in front, its posterior part long, attenuate, and passing considerably beyond hind femora in the typical long-pronotumed form (sometimes called *A. granulatum granulatum*),* its median carina prominent throughout its length, but not crested; hind wings reaching about apex of pronotum, and with a delicate network of veins. Pronotum and legs finely granulated, and dorsal surface of former with short wrinkles. Readily recognized from our other related species by the prominent angulate form of front margin of vertex.

Colour.—Variable, but usually described by writers as grayish or reddish brown, sometimes blackish, often with a whitish median band along the full length of the pronotum; inner wings in life bluish or bottle-green in colour. A female specimen from Deerfield, Yar. Co., N. S., (3 June, 1915), the only Nova Scotian specimen I have seen, is blackish-brown, with a narrow, cream-coloured border along sides of head and continued along dorsal margins of pronotum; femora dark, with very slightly lighter transverse bands, and a cream-coloured line along upper edge; tibiæ blackish; hind wings transparent, except anterior margin which is dark.

Measurements.—Male: body, 8.5-13.5 mm.; pronotum, up to 11.5 mm.; hind femora, 6 mm. Female: body, 11-15.3 mm.; pronotum, up to 15.5 mm.; hind femora, 7 mm. (The Deerfield, N. S., female specimen is 12 mm. from vertex to end of pronotum).

Range.—Eastern and northern North America, north of about lat. 38°: from Nova Scotia, Maine, Montreal, Ont., Man., Sask., Alb., and Vancouver (B. C.), south to New Jers., Ind., Kans., and Colo. Probably occurs throughout all of New England, preferring sedgy meadow lands and swales on sandy soil occasionally flooded by rains or freshets and perpetually moist

Occurrence in Nova Scotia.—This marsh-loving, slender grouse-locust was first reported from western Nova Scotia by C. B. Gooderham in 1917 (Proc. Ent. Soc. N. S. for 1916,

*A form with the pronotum and wings more or less abbreviated, and in extreme cases not passing the hind femora, has sometimes been called *A. granulatum variegatum* Hancock. It has not been taken in Nova Scotia.

p. 23). I have not detected it so far about Halifax, where the marshy tracts best suited to it, are not so common as in some of the western parts of the province. Still it should be looked for in marshy and boggy areas or low wet woods.

In the western parts of Nova Scotia it is rather common in suitable wet localities in Colchester, Hants, Kings, Annapolis, Digby, and Yarmouth counties. Only the typical long-pronotumed form (*A. granulatum granulatum* Kirby) has so far been taken; although the form sometimes called *variegatum*, with the pronotum and wings more or less abbreviated, may yet be met. In C. B. Gooderham's collection, Truro, there are twelve specimens (4 males and 8 females) taken by himself, E. C. Allen, G. F Collingwood, and Miss V. L. Tarris, at the following localities: Truro, Col. Co. (female, 15 April, 1917, and two others seen; one 22 April, 1917; female, 30 May; male, 18 June; female, 23 July, all in 1915); McNutt's Creek, Col. Co. (female, 16 May, '14); Kennetcook, Hants Co. (male, 6 June, '14); Windsor, Hants Co. (female, 22 July, '14); Wolfville, Kings Co. (female, 29 Aug., '12); Kentville, Kings Co. (female, 28 May, '16); and Yarmouth (2 males, 25 May, '14; 4 Oct., '04). In the Agricultural College collection, Truro, are two females, one taken 2 June, '16, and the other from Smith's Cove, Digby Co., 4 June, '15. In E. C. Allen's own collection is a female collected at Deerfield, Yar. Co., 3 June, '15. Total number, 4 males and 11 females. In these localities are found the wet, marshy conditions and sandy soil to which the species is adapted. It is quite likely that it will be detected, but more rarely, in some of the fewer similar areas which are situated on the Atlantic side of the province. The dates given above, show that it occurs at least from 15 April (when the grass is beginning to sprout) to 4 October. Like other species of the subfamily, it hibernates in the adult form, and thus is one of the earliest species to be met with in the province. The determination of Mr. Gooderham's specimens

has been verified by specimens examined by Dr. E. M. Walker of Toronto, Prof. W. S. Blatchley of Indianapolis, and J. A. G. Rehn of Philadelphia, all of whom agree as to their being *A. granulatum.*

Mr. Gooderham also has a single male long-pronotumed specimen taken at Truro, on an unrecorded date, which is somewhat abnormal. Prof. Blatchley stated it was *Acrydium ornatum ornatum* of Say, and I think Dr. E. M. Walker concurred in this. It was also submitted to Mr. J. A. G. Rehn of Philadelphia, who after carefully examining it, found that the front of the head is deformed, giving it the appearance of having a projecting median carina such as is present in *ornatum* but not normally in *granulatum.*

5. **Acrydium arenosum angustum** (Hancock). (Short-pronotumed form.)

?*Tettix ornata.* F. Walker, Cat. Derm. Salt. Brit. Mus., v, 813 (1871); Nova Scotia, etc.—Do., Can. Ent., iv, 31 (1872); Nova Scotia, etc.

Acrydium ornatum (not of Say). Gooderham, Proc. Ent. Soc. N. S. for 1916, 23, 27 (1917); Col., Kings, Hants, Ann., and Yar. Cos.

Description.—Nova Scotian specimens. Body rather robust; greatest width contained in length 2¼ times in male and 2⅓ in female; greatest vertical depth of thorax contained in same length 3 times in male and 3⅛ in female; apex of pronotum exceeding femur by about length of head; hind-wings to about end of pronotum or slightly shorter. Head, pronotum and legs granulated; abdomen less so; carinæ with larger and closely-set granulations. Median carina of face grooved; profile of face projecting before vertex, rather strongly hollowed before eyes, arching out strongly between antennæ, then gently curving in, and finally rising very slightly above the clypeus. Vertex nearly as wide as its length, very slightly concave between carinæ, its front margin only very slightly convex (being approximately a curve struck with the centre located at about front margin of pronotum), slightly indented in middle, and projecting in front of eyes for only 1/7 to 1/10 of width of vertex. Median carina of vertex on anterior three-quarters or all of head, but slightly raised, faintly convex in profile, its anterior end projecting very little beyond margin of vertex. Pronotum truncated and narrowed in front, nearly twice as broad at shoulders, lateral lobes constricted at ⅓ distance between anterior margin and shoulders. Disk of pronotum in shoulder region nearly flat transversely. Median carina distinguishable throughout entire length, but has slight prominence, except at the anterior eighth of its length where it rises and forms a sort of hump, anterior to which it is somewhat compressed. Anterior lateral carinæ separated about width of vertex, and become obsolete posteriorly at a distance a little less than

length of vertex. They re-appear behind this, but twice as wide apart, diverge to the shoulders and then converge to the apex, there being offshoots about midway which pass diagonally outward. The dorsal profile of pronotum at first rises until it forms the beforementioned hump whose greatest elevation is situated at about ⅛th of its length; then it is depressed, and again rises extremely slightly at about ⅓rd of the length, posterior to which it is nearly straight (with a slight tendency to concavity) to the apex. Lobe of rudimentary wing-cover elliptical, 2½ times as long as broad. Femur robust, 3 times as long as its greatest breadth.

Colour.—Nova Scotian specimens. Cinnamon-coloured, sometimes obscurely fuscous on disk of pronotum between shoulders; hind wings transparent, slightly iridiscent in some lights, front edge gray-brown, veins dusky; legs cinnamon, more or less mottled with fuscous. (The colour and markings, as in other related species, are subject to considerable variation).

Measurements.—The following detailed measurements I have very carefully taken microscopically from the three above-described specimens from Truro, N. S., viz. a male collected 17 July, 1913, a female taken on an unknown date, and another female dated 6 Aug. 1913. The last has the apex of the pronotum missing.

	Male 17-7-13	Female	Female 6-8-13
	mm.	mm.	mm.
Total length to apex of pronotum	8.95	10.00	....
Length of body to end of abdomen	7.23	9.25	9.40
Vertical thickness of thorax	2.45	3.00	2.85
Head, length	.90	1.00	1.08
Distance between extreme convexity of eyes	1.50	1.75	1.75
Width of vertex	.70	.90	.87
Vertex projects in front of eyes	.11	.09	.12
Pronotum, length	7.90	9.00	....
" anterior width	1.67	2.00	2.15
" width at shoulders	3.23	3.90	3.90
Lateral carinæ of pronotum, separation at anterior end	.85	1.10	1.00
Lateral carinæ of pronotum, separation at shoulders	2.35	2.90	2.80
Front of pronotum to more prominent hump of median carina	.95	1.25	1.15
Front of pronotum to less prominent hump of median carina	2.30	3.00	2.90
Pronotum extends beyond abdomen	1.65	1.40	....
Lobe of rudimentary wing-cover, length	1.62	1.75	1.85
" " " " width	.63	.75	.78
Hind wing	6.20	6.50	....
Hind femur, length	4.85	5.60	....
" " width	1.65	1.90	....
Hind tibia	4.10	4.70	....
Valves of ovipositor	....	1.10	1.28
Apex of femur to apex of pronotum	1.00	1.10	....

Range.—The range of this northern race of *A. arenosum* has not been fully worked out, but it occurs in Nova Scotia, New Hamp., and Mass. (Hebard coll.), southern Ont. (Walker, as *obscurum*), Minn. (Somes, as *ob-*

scurum), Ill. (Hancock, type locality), Ind. (Blatchley, as *obscurum*), and in the higher regions from New Jers. and Penn. south to North Carol. and Geo.; and no doubt will be found throughout the Alleghanian Division of The Transition Zone. (The southern typical race, *arenosum arenosum* of Burmeister, occurs in the lower country of the Carolinas [the type locality] and Georg., all of Flo. and on the Gulf Coast and westward, and thus is more restricted to the Lower Austral Zone.)

Occurrence in Nova Scotia.—The common, stout, short-pronotumed grouse-locust of western Nova Scotia, which we have described, is here placed under the name *Acrydium arenosum angustum* of Hancock (1896) on the definite authority of J. A. G. Rehn, the well-known systematic orthopterist of the Philadelphia Academy of Natural Sciences, who has specially examined a number of specimens from this province. The geographic race *angustum* is the northern member of the *arenosum* species complex, of which the typical race (*arenosum arenosum* of Burmeister) is found in the lower country of the southern United States. Hancock's *obscurum*, as well as others of his so-called forms, such as *inflatum*, etc., are mere transitory variants of his *angustum*, the latter name having page priority in his original paper (Trans. Am. Ent. Soc., xxiii, 1896, 235-244), although some writers have incorrectly grouped the synonymy under *obscurum*. Hancock's *angustum* was a slender-bodied form, whereas, as a matter of fact our Nova Scotian insect agrees more closely with his stouter variant *inflatum* or *obscurum*, names which have been retired to the synonymy. The race *angustum* has been found in both a long- and a short-pronotumed or abbreviated form, the latter being the only one which has been collected in Nova Scotia.

In general appearance this abbreviated form has a close resemblance to *A. ornatum triangulare* of Scudder (1862) which is reported as occurring rather commonly in sedgy meadow-land in New England, and two of Mr. Gooderham's Truro specimens were given that name by Prof. W. S. Blatchley of Indiana who forwarded a specimen of *obscurum* for comparison. Dr. E. M. Walker of Toronto, however, had

identified them as *obscurum*, which, as we have said, is now held to be merely a stouter variant of *angustum*. On specimens being finally submitted to Mr. Rehn, the latter positively determined them as *A. arenosum angustum*, not *ornatum*. In a letter to me of 7 Nov., 1917, after having once more carefully examined our specimens, he reaffirms this, and says they are perfectly typical when compared with numerous specimens in the Hebard and other collections from the higher regions of North Carolina and northern Georgia, north to Pennsylvania and New Jersey, and that he has also before him material from Massachusetts and New Hampshire. Knowing the high standing of this gentleman as an authority on North American systematic orthopterology, and the very extensive collections to which he has access, we accept his decision. Personally I may say that, after comparing specimens with Hancock's original description, I consider Mr. Rehn's identification to be correct, our form being merely a more robust variant of *angustum*, such as Hancock termed *inflatum*.

No New England writer, I think, has included *A. arenosum angustum* in his published list, Scudder in 1900 mentioning only *granulatum* and *ornatum*, the short form of the latter being his *triangulare*. The present finding, therefore, has a bearing on conditions in New England, where *angustum* has probably been included in *ornatum*. There is, of course, no reason why the latter species should not occur here also, and it should be looked for.

F. Walker in 1871 (Cat. Dem. Salt., v, 813) reported "*Tettix ornata* Harris" as occurring in Nova Scotia, from a single specimen collected, probably about 1821, by Lieut. Redman. This specimen is still in the British Museum, and B. M. A. Cummings informs me that it is correctly determined as *T. ornatus*. Walker's name must refer to a long-pronotumed form, as he also recognized and listed *T. triangularis*, although not reporting the latter from Nova

Scotia. All that can be done at present, is to very doubtfully refer Walker's record to the form now under consideration, until *ornatum* can be verified as occuring here or Walker's specimen has been re-examined. Mr. Gooderham has a single Truro specimen which had been determined as the long-pronotumed form of *ornatum*, but it has since been identified as a deformed specimen of *A. granulatum* as stated under that species.

Leaving nomenclatural questions to be a subject for further investigation, we will now deal more particularly with the occurrence of *A. arenosum angustum*, short-pronotumed form, in Nova Scotia. This broad-shouldered, robust grouse-locust, with the pronotum extending to about the end of the hind femur, has so far not been found by me near Halifax. It is, however, common about Truro, Col. Co., and is more or less so in suitable localities in other parts of the western section of the province. There are three specimens in the collection of the N. S. College of Agriculture, and Mr. Gooderham has a number of others collected at various dates from 18 June to 20 August, at Truro, and in Hants, Kings, Annapolis and Yarmouth counties. He reports it as very common about Truro, where it occurs mostly along the banks of streams and in boggy places; and as it hibernates like other species of the genus, it should be about from early spring, probably the middle of April, until autumn, although the earliest and latest dates so far actually noted are, as we have said, the middle of June and the latter part of August.*

Subfamily **Acridinæ** (Oblique-faced Spineless Locusts)†

(*Tryxalinæ* of former writers.)

Size rather large; pronotum never extending back over abdomen; *no spine or tubercle on prosternum between front*

*Besides the possibility of *Acrydium ornatum* of Say occurring here, more thorough search may disclose the rare presence of *Tettigidea parvipennis* (Harris), which occurs north to Mass., Maine and Ont., being abundant in New England in moist, grassy and sedgy meadows. It may be recognized by its 22-jointed antenna and by the front femur being grooved along its upper margin.

†See footnote regarding the unfortunate similarity in the names of the subfamilies *Acrydiinæ* and *Acridinæ*, on page 253.

legs; face oblique and usually meeting vertex at an acute angle; *median carina of pronotum never raised as a crest* or cut by more than one tranverse linear groove; wings never brightly coloured or with dark band.—The winter is passed in the egg state, oviposition taking place in early autumn. Stridulation is produced by rubbing the hind femora against the roughened intercalary vein of the wing-covers, when at rest. Despite the similarity of the name of this subfamily with that of the *Acrydiinæ*, beginners must be careful to distinguish between the two names.

KEY TO NOVA SCOTIAN GENERA OF ACRIDINÆ (TRYXALINÆ).

a. Antennæ linear; lateral foveolæ (small depressions) of vertex small and *not visible from above*............................ORPHULELLA, p. 264.

aa. Antennæ linear; foveolæ of vertex plainly *visible from above* as linear depressions between the eyes and the apex.

b. Median carina of pronotum not high, and *not cut in front of middle by principal sulcus* (transverse groove), the notch so formed being a little behind the middle...................CHORTHIPPUS, p. 266.

bb. Median carina of pronotum rather high and sharp, and plainly *cut somewhat in front of middle by principal sulcus*................. MECOSTETHUS, p. 269.

Group Orphulæ.

6. ? **Orphulella speciosa** (Scudder).

Orphulella speciosa. Scudder, Can. Ent., xxxi, p. 184 (July 1899); "Halifax, N. S., Piers."

Description.—Face very oblique; vertex blunt, rounded, obtuse in female, right-angled in male; central depression close to apex; *foveolæ indistinct and not visible from above;* lateral carinæ of pronotum very little incurved, the distance between them little greater at hind margin than at front; principal sulcus cuts median carina of pronotum somewhat behind middle; wing-covers usually reach ends of hind femora although varying from 3 mm. short to 3 mm. beyond them in male, and from 1.5 mm. short to 2 mm. beyond in female

Colour.—Very variable, the more striking variations being (a) head, disk of pronotum and wing-covers green (b) head and disk of pronotum green, tegmina rose-red; (c) head and pronotum brown, wing-covers rose-red, and (d) head, pronotum, and wing-covers brown. A dark line from behind the eye reaches back onto the pronotum, along the lateral carinæ, the latter being whitish. Wing-covers with a few small spots, sometimes wanting; hind femora greenish or brownish, not banded; hind tibiæ dull brown or yellowish, without pale ring near base.

Measurements.—Male: body, 13-14 mm.; antennæ, 4.5-6.5 mm.; wing-covers, 10-13 mm.; hind femora, 8.5-10 mm. Female: body, 16-21 mm.; antennæ, 5-6.5 mm.; wing-covers, 9-16 mm.; hind femora, 10-12 mm.

Range.—Eastern and central North America: from Nova Scotia (??) (Scudder, probably an erroneous record), Maine, St. Anne de Bellevue, P. Q. (Gooderham MS.), and southern Ont., south to Texas, and west to Minn. and Nebr. Very abundant in New Eng.

Reported occurrence in Nova Scotia.—Dr. Samuel H. Scudder, in his paper on "North American Species of Orphulella", in the Canadian Entomologist, London, Ont., vol. xxxi, page 184 (July, 1899), says of *Orphulella speciosa*, "I have before me a series of specimens from Halifax, N. S., Piers; Moosehead Lake, Scudder; Norway, Smith;" etc.; and in his "Catalogue of the Described Orthoptera of U. S. and Canada" (Proc. Davenport Acad. of Sc., viii, 24, 1901), he gives its range as "Nova Scotia to Texas," a statement which has been copied by other writers. I have no recollection whatever of this specimen to which Scudder attaches my name, or when it was taken; although I sent him various specimens from Halifax during 1895. I am absolutely certain that Scudder never reported to me that this species was among those I sent him, and the record must be open to the very greatest doubt.

Mr. Gooderham informs me that he has never taken or heard of *O. speciosa* being taken in Nova Scotia. He has a single specimen collected at St. Anne de Bellevue, Quebec province, and has compared it with ninety-six specimens of *Chorthippus curtipennis* from Nova Scotia. In all his Nova Scotian specimens the foveolæ are present and easily seen from above, so that there can be no doubt that the specimens from this province generally have been correctly determined as *C. curtipennis*. I have had the same experience in examining many specimens taken by myself about Halifax, and Dr. E. M. Walker confirms our determination of *C. curtipennis*.

Taking all the circumstances into consideration, I feel reasonably confident that Scudder made some mistake in his record, and it is merely included here on his authority as before quoted. The occurrence should at least be verified by a new record before fully accepting *O. speciosa* as a member of our fauna, and supposed specimens of *C. curtipennis* should be examined to see if *Orphulella* is included among them.

This species is very abundant throughout New England, where it reaches maturity early in July, and is found nearly everywhere on dry, sandy or loamy soils of pastures and cultivated fields; and therefore its occurrence in Nova Scotia in similar situations is not by any means a thing to be entirely unexpected.*

Group Stenobothri.

7. **Chorthippus curtipennis** (Harris). SHORT-WINGED BROWN LOCUST.

Stenobothrus curtipennis. F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 754 (1870); Nova Scotia.—Do., Can. Ent., iv, 31 (1872); Nova Scotia.—Piers, Trans. N. S. Inst. Sc., ix, 213 (1896); Nova Scotia.

Chorthippus curtipennis. Gooderham., Proc. Ent. Soc. N. S. for 1916, 25, 27 (1917); Col., Kings, Hants, Ann., Digby, Yar., and Queens Cos.

Description.—Nova Scotian specimens. *Foveolæ of vertex plainly discernible from above* as linear depressions; median carina of pronotum not high or sharp, cut somewhat *behind the middle,* lateral carinæ incurved; wing-covers of male usually reaching end of abdomen, and of female usually covering about two-thirds of abdomen, although they may be longer or shorter in each sex; wings slightly shorter than wing-covers; hind femora rather slender.

Colour.—Nova Scotian specimens. Variable; green, greenish-olive-gray, and brownish colour-phases being found in this province. The difference between these three phases mainly depends on the colour of the sides of head and of pronotum, which are of one of these tints. There are varying degrees of intensity of these colours, but a number of specimens can be fairly easily placed in the three groups. Descriptions of these phases, from adults taken at Halifax, 14 Aug., 1917, are as follows:—

Green phase.—Upper part of head, of pronotum, and of abdomen pale vinaceous-cinnamon. Face, sides of head, of pronotum, and of thorax pale chromium-green, which gives this variant its predominant colour. Sides of abdomen vandyke-brown. Under parts brownish yellow. Often two black lines on upper part of head between eyes; but these sometimes wanting. Narrow black line from eye to pronotum, continued on latter as presently described. Lateral carinæ of pronotum whitish; margined outwardly by a black line (a prolongation of that from the eye), which extends to beyond the middle of pronotum; and margined inwardly by a shorter black line on the posterior two-fifths of the disk. Thus the whitish sinuous line of the lateral

Chloealtis conspersa, Harris, the Sprinkled Locust, is not uncommon near dry woodland in New England, north to Maine, and also has been reported from Ont., Man., and Alb., and might possibly be found in southern Nova Scotia. The antennæ are long (10-12 mm.); male wing-covers well developed, with the scapular area dilated; female wing-covers usually abbreviated to half length of abdomen, and wings aborted. The males resemble those of *Chorthippus curtipennis* but may be distinguished by the absence of the foveolæ, the broader black bar on sides of pronotum, and the larger and more robust body.

carina seems to pass diagonally across a black line which therefore adjoins it first on one side and then on the other. Wing-covers brownish cream-buff. Hind femora pale vandyke-brown on disk, upper edge chromium-green, lower edge yellowish, knee black; hind tibiæ pale vandyke-brown, narrowly blackish at base.

Greenish olive-gray phase.—Upper parts of head and pronotum cream-colour; upper part of abdomen cream-buff with a black spot on anterior part of each segment. Face whitish; sides of head and of pronotum tea-green (greenish olive-gray), which gives this variant its predominant colour; sides of abdomen black, more or less marked with yellowish. Under parts canary-yellow. Sometimes two black lines on top of head; a black bar from eye to pronotum. The white lateral carinæ of pronotum, and adjoining velvety-black lines, are disposed in precisely the same manner as those of the green phase. Wing-covers cream-buff on dorsal area, wood-brown on lower area; veined with fuscous. Hind femora brownish olive-green on disk, canary-yellow on basal half of lower edge, knees black; hind tibiæ wood-brown, narrowly banded with black at extreme base; spines black.

Brownish phase.—This resembles the greenish-olive-gray and green phases, except that the sides of head and pronotum are brownish of yellowish-brown.

Of 9 specimens (5 adults and 4 nymphs) taken on the beforementioned date, 3 were green, 2 were olive-gray, and 4 were brownish. Of the males, 2 were green, 2 were olive-gray, and 1 was brownish; and of the females, 1 was green, and 3 were brownish. The two black lines on top of head were wanting on 2 (females) of the brownish lot, and also on 1 (male) of the green lot. In the adult males the wing-covers reach to the end of the abdomen, and in the adult females they cover about two-thirds of it.

Measurements.—Nova Scotian specimens. Male: body, about 15 mm.; antennæ, 8.7 mm.; pronotum, 3 mm.; wing-covers, about 9.5 mm (2.2 mm. short of end of hind femora, but varies); hind femora, 10 mm.; hind tibiæ 9.5 mm. Female: body, about 18.5 mm. (but varies); antennæ, 6.7 mm.; pronotum, 3.5 mm.; wing-covers, about 9 mm. (5.2 mm. short of end of hind femora, but varies); hind femora, 12.2 mm.; hind tibiæ, 11 mm. Writers have described a short- and a long-winged form (the latter sometimes called var. *longipennis*), but they intergrade. In the former the wing-covers are usually about 2.5 mm. (males) or 4 mm. (females) short of end of hind femora; while in the latter they reach the end of femora or slightly surpass them. In Nova Scotian males they mostly reach the end of the abdomen, and in females they usually cover about two-thirds of it; that is in the former their apex is about 2.2 mm. short of the apex of the hind femora, and in the latter about 3 mm. short of the end of the abdomen and about 5.2 mm. short of the femoral apex.

Range.—Northern United States and Canada east of Sierra Nevadas and mostly north of lat. 40°: from southern Nfld., P. E. Island, Man., Sask., and Alb., south to N. Caro., Ill., Neb., Colo., and Nev. It is thus mostly confined to the Canadian and Transition Zones and probably the northern portion of the Upper Austral. One of the commonest species in New England and other parts of its range.

Occurrence in Nova Scotia.—This very common species was first recorded from Nova Scotia by F. Walker in 1870. In Aug., 1912, B. Long collected 31 specimens in the neighboring province of Prince Edward Island, and also took it at Moncton, N. B. (E. M. Walker, Can. Ent., 47, 1915).

As we have seen, the green, the olive-gray, and the brownish colour phases are found in Nova Scotia. The species is very abundant throughout the province in somewhat damp places well covered with succulent grasses, and also about dryer meadows and thick growths of roadside ferns, such as the sweet Hay-scented Fern (*Dicksonia punctilobula*), in dry locations. Hundreds rise from about the feet when walking through short grass. Despite its numbers, it probably does not do very much damage to crops which are of value. I have noted it about Halifax, Lawrencetown (Hx. Co.), Westville (Pict. Co.), Tatamagouche (Col. Co.), Windsor (Hants Co.), Kentville (Kings Co.), Lunenburg Co., etc.; and C. B. Gooderham states that it is excessively abundant about Truro, Col. Co., and also reports it from the additional counties of Annapolis, Digby, Yarmouth, and Queens. Although there happens to be no records of its occurrence in Cape Breton Island, yet, no doubt, it is also abundant there.

It is a fairly early species, and probably hatches about Halifax in the latter part of June, as I have observed many nymphs, from 6 to 8 mm. long, and of about the third stage, in grass about damp places near Halifax on 7 July, 1917, which was a backward season. Adults are met with from about the latter part of July or first of August about Halifax (27 July, 1897, Halifax; earliest date at Truro, 6 July, 1914)*, until about 25 October (19 Oct. '95, 25 Oct. '96, 26 Oct., '97, 26 Oct. '17, at and near Halifax). At noon on 18 Nov., 1917, a sunny warm day with a temperature of 49°, I took an active male (greenish olive-gray phase) in a very sheltered warm spot covered with grass and fallen leaves, at the edge of a wood in the archbishop's grounds, Dutch Village, Halifax, although the frost had previously been so severe that on 15 Nov. the head of the North West Arm was frozen over. This must only be taken as a mere casual survival of an individual in a peculiarly favourable situation.

*In 1917 the first adults and first stridulation of this species were noted at Halifax on 14th August.

The stridulation or call of this very common locust sounds like the lisping syllables *thru*, *thru*, *thru*, repeated from about seven to ten times, and lasting altogether three or four seconds. It is a soft, dreamy, lulling sound of the country, and quite characteristic of a quiet, hot forenoon in August and September, and is still heard in October. The insect may be seen producing the notes by raising the hind legs and grating the thighs against the outer surface of the wing-covers. These notes are heard from about the beginning of August, or perhaps earlier, and as long as the adults are about; but the sound is quite faint at the end of the season,—in fact the species calls most frequently during hot sunny days. The male is a fairly active and noiseless flier, but the female usually escapes by leaping.

Group Epacromiæ.

Key to Nova Scotian Species of Mecostethus.

a. *Scapular area of wing-covers with a pale (yellow) streak;* intercalary vein of male wing-cover with very obscure, low teeth......8. *lineatus*, p. 269.

aa. *Scapular area of wing-covers without a pale streak;* intercalary vein of male with minute, sharp, elevated teeth.............9. *gracilis*, p. 271.

8. **Mecostethus lineatus** (Scudder).

Mecostethus lineatus. Gooderham. Proc. Ent. Soc. N. S. for 1916, 25, 27 (1917); Kings and Yar. Cos.

Description.—Foveolæ of vertex visible from above; pronotum with three distinct carinæ, the median rather high and sharp, plainly cut by principal sulcus somewhat in front of middle; lateral carinæ distinctly divgent behind; prozona (front part of pronotum) shorter than metazona (hind part); *intercalary vein of male wing-cover with very obscure, low teeth;* wing-covers and wings well developed, surpassing end of femora by about one-third of tibia.

Colour.—Nova Scotian female. General colour brownish with yellow markings; beneath yellowish-green; wing-covers with a pale yellowish streak. Head and pronotum dark vandyke-brown, the latter liver-brown on the lateral lobes; labial region light olive-buff. Pronotum liver-brown on lateral lobes, lighter on disk; under parts of prothorax oil-green. Abdomen dark clove-brown (nearly black) above and on sides, beneath light apple-green; a pale yellow, somewhat broken line along each side of upper part of abdomen, and three similarly coloured spots on sides of abdomen. A distinct, pale canary-yellow narrow line extends from near upper part of eye, along side of head, and continues, somewhat broader, on the lateral carinæ of the pronotum. A pale, canary-yellow dash, rather broad, extends diagonally across posterior part of cheek and anterior part of pronotum. Wing-covers pale cinnamon-colour, darker at base and on sides. From the base a *distinct pale canary-yellow line extends near the lower (anterior) edge* until it reaches about the middle of the length of the wing-cover; the apical part of this line is broken up and so

extends on the uneven lines of the veins. This yellow line appears as a continuation of the similarly-coloured one from the eye along the lateral carina of pronotum. Hind wings brownish along anterior (lower) part, and pale yellow on posterior (upper) part. Fore and middle legs liver-brown or bay above. Hind femur olive on outer face, becoming blackish near apex, and a group of three whitish spots, about midway, on outer face; upper edge of femur brownish, and lower edge light maroon, with two black marks, separated by a yellow one, near apex. Hind tibia buff-yellow with faint dusky annulation near base and also dark near apex.

Measurements.—Male (vide Blatchley): body, 26 mm.; wing-covers, 25 mm.; hind femora, 17 mm.; hind tibiæ, 16.5 mm. Female (Nova Scotian): body, 36.7 mm.; wing-covers, 32 mm.; hind femora, 20 mm.; hind tibiæ, 19.2 mm.

Range.—Northern United States and southern Canada east of the Great Plains, north of about lat. 40° and east of about long. 100°: from Nova Scotia, P. E. Island, Maine, Que., Ont., and Man., south to New Jers., Ind., Iowa, and Neb. It thus occurs in the Canadian, Transition, and probably the northern part of the Upper Austral Zones. It is generally a rather uncommon species and reported but a few times in a district; but Morse states it is rather common in southern New England in wet, sedgy meadows, and in Mass. and Maine it occurs at elevated points.

Occurrence in Nova Scotia.—This large, handsome species, with its bold, graceful outlines, seems to be somewhat rare in Nova Scotia, and is doubtless local in occurrence. The wet meadows of the western part of the province should be more favourable to it than the Atlantic coast where such places are less frequent. I had not found it when I published my paper in 1896, but on 26 October, 1897, I collected the first specimen, a female, in wet sea-marsh grass, on the West Marsh, Lawrencetown, Halifax Co., a description of which has been given. This is the only one I have met with here. In C. B. Gooderham's collection are two specimens taken by E. C. Allen, viz., a male from Yarmouth Co. (Deerfield?), and a female from Kings Co. (Wolfville?), but without dates. I understand that Mr. Gooderham has also seen two which had been taken at Yarmouth on 29 Aug. Bayard Long took six specimens at four localities in Prince Edward Island in Aug. and Sept., 1912 (E. M. Walker, Can. Ent., 47, 341, 1915), so that the northern limit of its range is not in Nova Scotia. Dr. E. M. Walker has found it quite plentiful in Ontario, in low, wet, sedgy meadows bordering lakes and slow streams (Can. Ent., 30, 125, 1898). Further search in suitable wet localities in Nova Scotia may show it to be

less rare than supposed. It should be looked for among the stems of tall grasses and sedges in low, boggy ground. The male is shy and difficult to approach, and is active, flying rapidly and noiselessly; while the female is more sluggish and secretive. It probably occurs in the mature state from about the latter part of July to near the end of October, the Lawrencetown date of 25 Oct. being no doubt representative of the very last days of its existence.

9. **Mecostethus gracilis** (Scudder).

Mecostethus gracilis. Piers, Trans. N. S. Inst. Sc., ix, 215 (1896); Halifax and Cow Bay (Hx. Co.).—Gooderham, Proc. Ent. Soc. N. S. for 1916, 25, 27 (1917); Col., Kings, and Yar. Cos.

Description.—This, like *M. lineatus*, is a handsome species, with trim lines and pleasing colouration, the dash of light red on the femora giving it a jaunty, attractive appearance. In general description it very closely resembles *M. lineatus*, except that the intercalary vein of the male wing-cover has sharp, elevated, minute, closely-set teeth.

Colour.—In colour also it fairly well resembles *M. lineatus*, except that the *scapular area of the wing-cover is without the pale yellow streak* which is so noticeable in that species. The hind femora of *gracilis* are yellowish with some small brownish markings, and the apex black with a yellow line on top; the lower edge of the hind femora is a striking, bright red. Hind tibiæ yellow with a black annulation at base and another on the basal third, the apex being dusky. Fore and middle legs yellowish. It may very readily be separated from *M. lineatus* by the absence of a pale yellow streak along the scapular area of the wing-covers.

Measurements.—Nova Scotian specimens. Male: body, 21 mm.; wing-covers, 20-20.5 mm.; hind femora, 14.5-15 mm.; hind tibiæ, 12.5-13.7 mm.; antennæ, 11 mm.

Range.—Northernmost United States and southern Canada, east of about long. 100°: has been reported from southern Nfld., Nova Scotia, P. E. Island, Maine, New Hamp., Mass. (northern and elevated parts of New Eng. from summits of White Mtns. to Berkshire Hills), Ont., Man., Sask., Alb., New Jers., Minn., Nebr., and Dak. Chiefly confined to the Canadian and Transition Zones. Its distribution to the south seems somewhat irregular.

Occurrence in Nova Scotia.—This species was first recorded from Nova Scotia by the present writer in 1896, and it was the first record for Canada exclusive of Scudder's original (1862) record for Manitoba. On 26 Aug. 1912, Bayard Long collected one male at Dundee in northern Prince Edward Island, and so extended its eastern range northward (Walker,

Can. Ent., 47, p. 341, 1915), and recently it has been taken in southern Newfoundland. In Nova Scotia the species is no doubt rather uncommon to common, according to localities. It is probably local in distribution, as about Truro, Col. Co., Mr. Gooderham reports it as common, while so far I have only collected four specimens near Halifax, all the latter being males. The first of these was taken in long grass in a dry location on the summit of Blockhouse Hill, near Fairview, Halifax, on 1 Sept., 1895. The remaining three were all captured in a damp, grassy spot on the roadside near Cow Bay Bridge, Cow Bay, about seven miles southeast of Dartmouth, Hx. Co., on 2 Oct., 1895. The determination of one of these specimens was verified by Dr. S. H. Scudder.

C. B. Gooderham has since collected the species at Truro, Col. Co., and also noted it from Kings County and Yarmouth. He took eight males at Truro, in Aug., 1913, and two males at the same place on 16 Aug. 1915. Some males were also sent to him from Kings County, where he has also seen it alive, and E. Chesley Allen gave him a broken male from Yarmouth. He has never captured a female, as the latter is said to be very sluggish and seldom takes to wing, whereas the male is an active flyer. The species, he says, does not appear to be very common in the western part of the province, and it is only found there among long grass and sedges in swampy places. Generally it is to be expected to occur in such habitats, although one of my Halifax specimens was from a moderately high (175 feet) and quite dry situation. The earliest and latest dates on which it has happened to have been taken, are 9th August (Truro) and 2nd October (near Halifax); but no doubt these dates do not correctly represent the full period of its occurrence with us as an adult. They may, however, assist others in defining the period more accurately. One would expect to find it from the latter part of July to the latter part of October.

Subfamily **Œdipodinæ** (Vertical-faced Spineless Locusts).

Size rather large; colour dull brown or grayish; pronotum not extending over abdomen; no spine or tubercle on prosternum between front pair of legs; face nearly or quite vertical; median carina of pronotum usually *raised as a crest and usually cut by more than one tranverse linear groove,* wings usually brightly coloured. Most species are peculiar, in that they stridulate when in flight; the cracking or rattling notes being produced by rubbing the under surface of the wing-covers against veins on the upper front surface of the hind wings. Other species stridulate as in the subfamily *Acridinæ* by rasping a series of teeth on the hind femora against a roughened vein of the wing-covers. The winter is passed in the egg state.

KEY TO NOVA SCOTIAN GENERA OF ŒDIPODINÆ.

a. Disk of hind wing transparent, not bordered by black; median carina of pronotum faintly cut by one sulcus (notch)..........CAMNULA, p. 274.
aa. Disk of hind wing opaque, coloured.
  b. Disk of hind wing black, bounded by a pale greenish-yellow border, apex smoky and having a few darker spots; median carina of pronotum cut by one deep sulcus..................DISSOSTEIRA, p. 278.
  bb. Disk of hind wing yellow, with a broken dark median tranverse band, apex dusky; median carina of pronotum cut by two sulci. CIRCOTETTIX, p. 281.

The student is cautioned that the above very artificial key only refers to such genera as have so far been reported from Nova Scotia, and that it will not answer should the number of represented genera be increased here. As it is quite probable that other genera may yet be found in the province, the following key has been extended so as to embrace those of possible occurrence here, the names of which are inclosed in square brackets.

KEY TO GENERA OF ŒDIPODINÆ FOUND OR LIABLE TO BE FOUND IN NOVA SCOTIA.

a. Median carina of pronotum raised as distinct crest and not notched by principal sulcus. (Inner wings bright sulphur-yellow on basal two-thirds, beyond which is a broad curved dusky band with a dark offshoot extending to near base)..................................[ARPHIA*].

**Arphia sulphurea* (Fabricius). Sulphur-winged Locust.—Common in pastures in New England, north to Maine and southern Ont., and may possibly yet be taken in south-western Nova Scotia. In this species, which is generally of a yellowish-brown or brown colour, the median carina of pronotum is *not* notched at all by the principal sulcus; and the hind wings have the basal two-thirds bright sulphur-yellow and the outer third covered by a curved dusky band with a dusky offshoot extending to near base. Length, male, 18 mm.; female, 27 mm. F. Walker in 1870 reported *Œ. sulphurea* from Nova Scotia (Cat. Derm. Salt., iv, 731; and Can. Ent., iv, 1872) but his specimen proves on re-examination to be *Circotettix verruculatus* (see that species).

aa. Median carina of pronotum less prominent and in female always notched by one or more sulci.

- b. Median carina of pronotum notched by only *one sulcus*.
  - c. Disk of hind wing nearly transparent, not distinctly bordered by black.
    - d. Disk of pronotum roof-shaped, front margin angulate. (Hind wings transparent, yellowish at base, remaining two-thirds smoky, paler at apex, a dark bar along middle of front margin).....................[CHORTOPHAGA*].
    - dd. Disk of pronotum flat, front margin truncate.
      - e. Median carina of pronotum prominent, higher in front than behind. (Hind wings transparent yellowish at base, outer half smoky and apex darker) .... [ENCOPTOLOPHUS†].
      - ee. Median carina of pronotum low, of equal height throughout, faintly notched by principal sulcus. (Hind wings transparent with dark nervules.) CAMNULA, p. 274.
  - cc. Disk of hind wing opaque, coloured (red or yellow bordered with fuscous, or black bordered with yellow).
    - f. Pronotum with lateral carinæ extending in front of principal sulcus and not cut by it; disk of pronotum usually with numerous tubercles; body robust, large. (Hind wings red or yellow, margined with fuscous)...HIPPISCUS, p. 277.
    - ff. Pronotum with lateral carinæ extending only to principal sulcus and cut by it; its disk with few if any tubercles; body slender, smaller. (Hind wings black with yellow border.) .. DISSOSTEIRA, p. 278.
- bb. Median carina of pronotum notched by *two sulci*, front notch often less distinct than hind one; hind wings with two or three radial veins greatly enlarged. (Hind wings yellow, with a dark median transverse band widening behind.) ....CIRCOTETTIX, p 281.

Group Œdipodini.

10. **Camnula pellucida** (Scudder). CLEAR-WINGED LOCUST.

Camnula pellucida. Piers, Trans. N. S. Inst. Sc., ix, 214 (1896); Halifax and Cow Bay (Hx. Co.).—Goodenham, Proc. Ent. Soc. N. S. for 1916, 26, 27 (1917); Col., Kings, Hants, Ann., Digby, Yar., Queens, Vict., Inver., and Cumb. Cos.

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* *Chortophaga viridifasciata* (De Geer). Green-striped Locust.—Abundant everywhere in New England and generally distributed in southern Ont. and may possibly yet be taken in southwestern Nova Scotia. Median carina of pronotum cut by principal sulcus; pronotum disk roof-shaped, sides sloping, dorsal front margin angulate; and hind-wings transparent, yellowish at base, with apical two-thirds smoky, paler at apex, and a dark bar along middle of front margin. General colour is green or brown. Length, male, 17-20 mm.; female 22-32 mm.

† *Encoptolophus sordidus* (Burmeister). Clouded Locust.—Very common throughout New England and occurring north to Montreal and southern Ont., and may possibly yet be taken in southwestern Nova Scotia. Colour rusty-yellow or brown, mottled with darker or lighter shades of brown. Disk of pronotum flat, the dorsal front margin truncate; median carina of pronotum prominent, higher in front, distinctly notched by principal sulcus; hind wings transparent yellowish at base, outer half smoky, darker at apex. Length, male, 20 mm; female, 24-35 mm.

Description.—Size rather smaller than most of the *Œdipodinæ*. Head compressed; antennæ short; pronotum with disk flat and smooth, much wider behind, truncate in front, obtusely angled behind, its median carina low, of equal height throughout, faintly cut once by principal sulcus in front of middle; sides of pronotum deeper than long; wing-covers narrow, reaching beyond abdomen.

Colour.—General colour light brown; antennæ pale at base, darker toward apex; a dark triangular spot behind eye, and a vertical dark spot on the front half of the lateral lobe of pronotum; wing-covers smoky-brown, with several dark and light patches on sides; the dorsal surface of covers dark brown with a yellowish stripe along each humeral angle; inner wings transparent, with dark nervules; hind femora yellowish brown with the apical part darker, and faintly marked with dark bars; hind tibiæ yellowish brown; abdomen yellowish beneath, sides darker.

Measurements.—Male: body, 17-21 mm.; antennæ, 7-9 mm.; wing-covers, 16-18 mm.; hind femora, 10-12 mm. Female (Nova Scotian): body, 27 mm.; antennæ, 6.5 mm.; wing-covers, 21 mm.; hind femora, 14 mm.; hind tibiæ, 12 mm.

Range.—Southern Canada and northern and western United States from Atlantic to Pacific: from P. E. Isld., Nova Scotia, Montreal, Manitoba, and Br. Columbia, south to Conn., northern Ind., Nebr., Colo., New Mexico, Ariz., and Calif. It thus occurs in the southern part of the Canadian, the Transition, and probably the northern portion of the Upper Austral Zones. In northern New England it is common, often excessively so, especially on dry hillsides.

Occurrence in Nova Scotia.—This somewhat sober-coloured locust, which lacks the brightly-coloured inner wings of most of the *Œdipodinæ*, is apparently rather uncommon about Halifax, but is reported to vary from common to very common in the western parts of the province where it is one of the most injurious species.* It was first reported from Nova Scotia in 1896. I captured a female, in company with *Circotettix verruculatus* (which it somewhat resembles when on the ground) in a stony place near Blockhouse (Stanford's) Pond, Fairview, Halifax, on 5 Sept. 1895; and a second female in a damp, grassy spot on the roadside close to Cow Bay Bridge, Cow Bay, about seven miles southeast of Dartmouth, Hx. Co., on 2 Oct. of the same year. The determination of the species was verified by Dr. S. H. Scudder who examined the latter specimen. Among some Orthoptera sent to me by Miss Lucy C. Eaton, was a third female taken by her at Truro, Col., Co. 23 July 1901 (Prov. Museum, Acc.

*Mr. Gooderham's statement (Acrididæ of N. S., 1917, p. 26), that it is "very common all over the province, occurring wherever *M. femur-rubrum* or *M. atlanis* is found," does not at all apply to the conditions about Halifax, where it is at most only uncommon.

No. 350). I have also seen specimens from Church Street, Kings Co. In the collection of the Agricultural College, Truro, are fifteen specimens taken in July and August at Truro, Col. Co.; Kentville, Kings Co.; and Smith's Cove, Digby Co. In C. B. Gooderham's collection are others taken by himself at Truro and Berwick (Kings Co.), and by E. C. Allen at Yarmouth. Gooderham has recorded it from the following counties: Victoria, Inverness, Cumberland, Colchester, Hants, Kings, Annapolis, Digby, Yarmouth, and Queens.*

It is probably somewhat local in distribution and its abundance varies considerably in different years. While uncommon in the vicinity of Halifax, it is common in suitable localities in the western parts of the province, and is reported as excessively common about Truro during some years and somewhat less so in other seasons. During the summer of 1913 it was so numerous at Truro, that when flushed it arose in clouds wherever there was vegetation, and in that season specimens were sent in from several counties, with complaints as to its abundance. In times of such abundance it is capable of doing considerable damage and should be closely watched. Since then, fortunately, the number has dwindled down to a large extent.

Gooderham has observed recently-hatched nymphs of this species, with a few of *Circotettix verruculatus*, in warm spots at Truro on 3 June, 1915. It has been taken in the perfect state from 14 July (Truro) until at least 2 October (Cow Bay, Halifax Co.). It should be searched for in dry situations, such as are frequented by others of the *Œdipodinæ*, and such are its haunts in New England, where it is very abundant in dry, grassy pastures and on untilled ground, preferably on high land; but in Indiana it occurs in low marshy land with short grass. Mr. Gooderham of Truro

* In Prince Edward Island B. Long collected eleven specimens in seven localities in Aug. 1912 (Walker, Can. Ent., 47, p. 341, 1915).

says it is met with in his district wherever *Melanoplus femur-rubrum* or *atlanis* is found. Its flight is low and direct, and usually silent, though it can also produce a slight rustling sound when on the wing.

11. **Hippiscus apiculatus** (Harris). CORAL-WINGED LOCUST.

H. tuberculatus of former writers.*

H. tuberculatus. Scudder, Psyche, vi, 303 (1892); Nova Scotia, etc.

Description.—Large and robust especially in female; head large, with swollen cheeks; vertex considerably produced in front of eyes. Pronotum slightly flattened apically, disk flat, more or less roughened and with numerous blunt tubercles; median carina low but distinct and cut by principal sulcus; lateral carinæ extending somewhat beyond the principal sulcus and not cut by it; *hind margins of pronotum acute-angled* (especially in female), *prozona (front dorsal part) much shorter than metazona (hind part)*. Wing-covers extending considerably beyond abdomen, especially in male. Hind femora very broad and flattened.

Colour.—General colour ash-brown, darker above; pronotum with a short longitudinal dark brown bar on its lateral lobes; wing-covers with fuscous and black blotches, the humeral angle usually light brown; hind wings usually bright coral-red (rarely yellow) at base, bordered outwardly by a curved fuscous band, with another band of fuscous along the median part of front or costal margin; outer face of hind femora with faint blackish bars, the apical half of inner face yellow crossed by a narrow black band; hind tibiæ yellowish to brownish.

Measurements.—Male: body, 25-30 mm.; pronotum, 8 mm.; wing-covers, 25-30 mm.; hind femora, 15-17 mm. Female: body, 40-43 mm.; pronotum, 11 mm.; wing-covers, 30-35 mm.; hind femora, 20-23 mm.

Range.—North America east of the Rocky Mountains, rare southwardly; reported from Nova Scotia (by Scudder only), Montreal (Caulfield, as *Œ. phœnicoptera*), Ont., Man., and Alberta, south to Fla., Missouri, Kans., and Colo., and west to Mont. and Wyom. Probably occurs chiefly in the Upper Austral, Transition and Canadian Zones.

Occurrence in Nova Scotia.—Unfortunately the sole record of the species' occurrence in this province, so far as I know, is the late Dr. S. H. Scudder's inclusion of "Nova Scotia (Jones)" in the list of localities where *Hippiscus tuberculatus* had been taken, in his monograph on "The Orthopteran Genus Hippiscus," in Psyche, vol. 6, p. 303, Cambridge, 1892. I suppose we should not throw doubt upon that record, particularly if Scudder had examined the specimen himself,

*Rehn and Hebard (Proc. Acad. Nat. Sc., Phila., 62, p. 630, 1910) point out the reason for adopting Harris's name, as Palisot de Beauvois, in 1805, had misidentified his United States material with Fabricius's *Gryllus tuberculatus*, an Old World species belonging to another genus.

which however he does not state. There is the possibility that Jones may have sent Scudder such a specimen, but it may not have actually been taken in this province. The Mr. Jones whose name is attached to the record, was, without any doubt, the late J. Matthew Jones, a well known Nova Scotian naturalist and president of the N. S. Institute of Science, with whom Scudder was in communication about 1876, and for whom he named the species of Orthoptera listed in Jones's "Visitor's Guide to Bermuda," Lond., 1876. Jones resided at Halifax and died there in 1888.

If it does occur here, as is not impossible from its known range, it must at least be rare and local, as it is a large, distinctively coloured and very conspicuous insect, particularly when in flight, and yet it has not been observed by either C. B. Gooderham or E. C. Allen in the western and southern sections of the province, or by myself about Halifax, and Mr. Long also did not find it in Prince Edward Island. Its occurrence here very greatly needs a new record for its verification before it can be accepted with confidence. Personally I am very strongly of the opinion that some mistake was made by Scudder in his record.*

The species is found throughout New England, but is there never very common and apparently is less abundant in the northern part of that region. It is usually found in dry, bushy pastures; and the male in flight produces a loud rattling note. In Ontario it is local in distribution, but where it does occur it forms colonies of considerable size.

12. **Dissosteira carolina** (Linnæus). CAROLINA LOCUST; BLACK-WINGED LOCUST.

Œdipoda carolina. F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 729 (1870); Nova Scotia, etc.—Do., Can. Ent., iv, 31 (1872); Nova Scotia, etc.

*The species might be expected to occur in Bermuda, where J. M. Jones had resided for some years before coming to Halifax, but it is not mentioned in that gentleman's list of Bermuda Orthoptera given on page 144 of his "Visitor's Guide."

Dissosteira carolina. Piers, Trans. N. S. Inst. Sc., ix, 214 (1896); Nova Scotia.—Gooderham, Proc. Ent. Soc. N. S. for 1916, 26, 27 (1917); Col., Kings, Hants, Ann., Digby, Yar., Queens, Lun., Pict., and Cumberland Cos.

Description.—Disk of pronotum with front margin nearly truncate and hind margin obtuse-angled; median carina high, cut in front of middle by deep narrow notch, its front lobe almost straight and the hind one arched; *lateral carinæ rounded and extending forward only to principal sulcus.* Wings and wing-covers extending about one-third their length beyond abdomen.

Colour.—Nova Scotian specimens. General colour varies somewhat, but is generally clove-brown (brown-black) and dark hair-brown; under parts lighter and more brown in tint, with a tendency towards mummy-brown. Wing-covers broccoli-brown, much clouded and obscurely spotted with clove-brown. Hind wings *dark clove-brown or black, with a primrose-yellow or pale sulphur-yellow outer border* the width of which is about one-sixth of length of wing, the apex smoky with several fuscous spots. Hind femora with inner face whitish and crossed by three blackish bands, the first nearly covering the basal half; hind tibiæ dirty yellowish.

Measurements.—Male: body, 26-30 mm.; antennæ, 10-11 mm.; pronotum, 7 mm.; wing-covers, 29-34 mm.; hind femora, 13-16 mm. Female: body, 34-40 mm.; antennæ, 12-13 mm.; pronotum, 10 mm.; wing-covers, 37-42 mm.; hind femora, 16-20 mm.

Range.—This common species is very widely distributed, occurring in Canada and the United States from Atlantic to Pacific: from Nova Scotia, New Bruns. (Point du Chene), Montreal, Ont., Man., and Br. Columbia, south to Fla., Miss., Central Amer. (?), New Mexico, and Calif. It thus occurs in the Canadian, Transition, Upper and Lower Austral zones. In New Eng. it is everywhere abundant.

Occurrence in Nova Scotia.—This species was first reported from Nova Scotia by Francis Walker of the British Museum in 1870, doubtless from specimens collected by Lieut. Redman about 1821. It is fairly common in all suitable localities in Nova Scotia, being found with *Circotettix verruculatus* on hot, dry, stony places, bare ground, dusty roadsides, and particularly on the ballast of railways; and it more or less resembles in colour the predominant tint of its habitat. It is much less abundant than *C. verruculatus* which it very closely resembles when on the ground, and with which it shares its habitat. Strange to say, Bayard Long did not happen to meet with it in Prince Edward Island in 1912, although it must surely occur there; but he collected it at Point du Chene, N. B., on 11 Aug., 1912 (E. M. Walker, Can. Ent., 47, p. 341, 1915).

I have found it common about Halifax and elsewhere; and C. B. Gooderham has specimens taken by himself at Avondale, Pict. Co., Truro and Black Rock, Col. Co., Kentville, Kings Co., and Round Hill, Ann. Co.; by W. E. Whitehead at Wilmot, Ann. Co.; and by E. C. Allen at Deerfield, Yar. Co. I have also noted specimens collected at New Glasgow and Westville, Pict. Co., (Piers), Elmsdale, Hants Co., (Piers), Church Street, Kings Co. (D. Hogan), Middleton, Ann. Co. (I. Cox), Brooklyn, Yar. Co. (D. Marrell), and Yarmouth, Yar. Co. (E. C. Allen). It has also been reported from Cumberland, Hants, Digby, Lunenburg, and Queens Counties. Several specimens are in the collection of the Agricultural College, Truro.

The first adults are noted near Halifax about 24 July (1897, North West Arm).* In October they are seldom observed and only on fine days; the last being usually seen on a warm day about the middle of October (5 Oct., '97, 12 Oct., '15, 28 Oct., '17). In 1917 single individuals were seen about Halifax, on bright days, on 8th, 14th, and 28th Oct., the last being a very slothful, half-perished female taken at noon on a sunny day when the temperature was 53°F. Oviposition probably takes place about the middle of September, as on the 12th of that month, 1897, I observed near Melville Island, North West Arm, Halifax, a number of the species which were particularly attracted to a warm spot where a load of sand had been left and which had become overgrown by grass on some parts, and there a female was evidently engaged in depositing eggs.

Frequently this insect makes a faint rustling or fluttering sound when flying. It usually proceeds in an erratic zig-zag manner when flushed, and on alighting, is apt to select a spot of ground with which its colour harmonizes, so that it is very difficult to detect until it is again put to flight. It

*Strange to say, I did not happen to note adults of this species in 1917 till about the end of August at Halifax, after which a fair number was seen each fine day.

usually does not fly far, but sometimes with a favouring breeze I have known it to proceed for thirty yards. As it frequents the roads and paths of man, it is familiar to all, although no special name is applied to it here. Most people confuse it with *C. verruculatus*, which some call the "Cracker," and with which it congregates; but in flight the two may be very readily distinguished, as *Dissosteira* has a *black hind-wing* bordered by yellow, whereas *Circotettix* has a *yellow wing* with a dark median transverse band. *D. carolina* is the largest locust in Nova Scotia with the exception of some females of *Melanoplus bivittatus* and *Hippiscus apiculatus*, which latter has been very doubtfully reported from here.

13. **Circotettix verruculatus** (Kirby). "CRACKER" (local); "SNAPPER" (local).

Œdipoda rugosa (not of Scudder). F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 731 (1870); Nova Scotia, etc.—Do., Can. Ent., iv, 31 (1872); Nova Scotia, etc.

Œdipoda sulphurea (not of Fabricius). F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 729-730 (1870); Nova Scotia, etc.—Do., Can. Ent., iv, 31 (1872); Nova Scotia, etc.

Circotettix verruculatus. Piers, Trans. N. S. Inst. Sc., ix, 214 (1896); Halifax and Ann. Co.—Gooderham, Proc. Ent. Soc. N. S. for 1916, 26, 27 (1917); Col., Kings, Hants, Yar. and Queens Cos.

Description.—Pronotum flattened on top, right-angled to acute-angled behind, its median carina elevated in front and *notched by two sulci* before the middle, the front notch often less distinct than the hind one; wings and wing-covers about as long as total length of body, the hind wings usually with three radial veins greatly enlarged.

Colour.—Nova Scotian specimens. Varies somewhat, but above usually black or blackish, often more or less finely marbled with gray, particularly about sides and front of head, and sides of pronotum. Underparts seal-brown to walnut-brown. Wing-covers grayish or brownish gray, blotched and sprinkled with brownish black, the larger blotches on the basal half. Hind-wings semitransparent; *pale sulphur-yellow on basal half*, with a few of the radial veins deeper in colour; this yellow area followed by a *crescent-shaped submedian band of blackish*, with a triangular, blackish, sub-costal offshoot with

its apex extending towards the base of the wing; beyond this a triangular, semi-clear area, veined with blackish, with its costal margin dusky; and the apex of the wing dusky. Hind femora pale smoke-gray or grayish white, with about four bands of black, the basal ones more or less merging into each other and the terminal one embracing the knee; the gray of femora most conspicuous as a subterminal annulation. Hind tibiæ pale smoke-gray or grayish white, banded at each extremity and submedially with black. Feet tawny-olive. Eyes black or black spotted with gray. Antennæ blackish.

Measurements.—Male (Nova Scotia): body, 24-25 mm.; antennæ' 10.5 mm.; pronotum, 5-5.2 mm.; wing-covers, 25-26 mm.; hind femora, 12-12.5 mm.; hind tibiæ, 10-10.5 mm. Female (Nova Scotia); body, 25.5-28 mm.; antennæ, 9.5-10 mm.; pronotum, 5-5.8 mm.; wing-covers, 24.5-27 mm.; hind femora, 11.5-13.5 mm.; hind tibiæ, 10-11 mm.

Range.—Canada from Atlantic to Pacific and northern United States from Atlantic to Rocky Mountains: from Nfld. (Port aux Basques), Nova Scotia, New Bruns. (Moncton), Montreal, Quebec, Ont., Man., Athab., and Br. Columbia (Vancouver), south to New Jers., Ill., Missouri, Nebr., Dak., Mont., and Colo. Though common on bare ledges in northern New Eng. it rarely occurs as far south as Mass. (Scudder, Orth. N. E., 1900). It is common in the mountains of New York, and in the southern part of its range is found at high elevations. It thus appears to be distributed over the Canadian, Transition, and elevated portions of the northern Upper Austral Zones or perhaps outliers of the Transition in that zone. In its southern limits, and no doubt generally, it is a more northerly species than *D. carolina.*

Occurrence in Nova Scotia.—Many years ago this species was collected in Nova Scotia, probably by Lieut. Redman about 1821, but Francis Walker of the British Museum in 1870 and 1872 erroneously determined the two specimens then taken as *Œdipoda rugosa* (= *Hippiscus rugosus* Scudder), and *Œdipoda sulphurea* (= *Arphia sulphurea* Fabricius), species which might possibly occur here but which have not yet been otherwise reported. He makes no mention of *Œdipoda verruculata* (= *Circotettix verruculatus*) as occurring outside of Massachusetts, U. S. A. (See Walker, Cat. Derm. Salt. Brit. Mus., iv, 729-731, 1870; and Can. Ent., iv, 31, 1872). In 1916, Mr. Cummings of the British Museum, examined for me Walker's single Nova Scotian specimen of "*Œ. rugosa*" which fortunately is still in that institution's collection, and it proves to be *C. verruculatus;* and under *C. verruculatus* in the same collection, is another specimen, of Walker's determination, from Nova Scotia, which had been named by him "*Œ. sulphurea.*" These two names of Walker, as far as they apply to Nova Scotian specimens,

must therefore become synonyms of *C. verruculatus*, which satisfactorily clears up a matter which otherwise would have been in doubt. This is as might have been expected, for the fact that he had not recorded the very common *C. verruculatus* from Nova Scotia, made it fairly certain that he must have misnamed it. Unfortunately F. Walker's names are apt to present considerable difficulties of this sort. *C. verruculatus* was first reported from this province under its proper name in 1896 (Trans. N. S. Inst. Sc., ix, 214). It is remarkable that B. Long did not happen to meet either this species or *D. carolina* in Prince Edward Island in 1912, where they undoubtedly must occur, although he collected them in southeastern New Brunswick (E, W. Walker, Can. Ent., 47, p. 341, 1915). The absence of *C. verruculatus* from that island would indeed be most remarkable, as it ranges north to southern Newfoundland.

Circotettix verruculatus is very common in Nova Scotia, in dry, warm, stony places, on bare ledges, hot and dusty roadsides and other bare, barren or burnt ground and particularly along railways. It is nearly always in company with the larger but less abundant *D. carolina*, which it much resembles when on the ground, though very easily distinguished in flight by the different colouring of the hind-wings. Its preference for places which readily come under man's eye, make it much in evidence. In this vicinity it shows no particular fondness for elevated places, as long as its habitat is very warm and dry. About Truro, Col. Co., Mr. Gooderham says it is specially abundant on old burnt land, and in that district also is more common than *D. carolina*.

In C. B. Gooderham's collection, Truro, are specimens taken by himself, E. C. Allen and others, in Colchester, Hants, Kings, Annapolis, Digby, Yarmouth, and Queens counties. I have also seen specimens from Bayfield, Antig. Co., and of course from Halifax Co. Gooderham has observed a few nymphs, just hatched, with more numerous nymphs

of *Camnula pellucida,* on 3 June, 1913, at Truro, in very warm places. Adults may be met with from about the middle of July (16 July, Truro; 18 July 1895 and 1897, Halifax), but its familiar cracking notes are not usually heard until about the end of July or first of August (25 July, '95, 6 Aug. '97, 16 Aug. '16, and 1 Aug. '17, all at Halifax). In the latter part of September as the weather becomes cool, they are less frequently heard; and they finally disappear about the middle of October. On 8 Oct., 1916, the last one was heard near the head of the North West Arm, Halifax, although we did not have a killing frost till 13 Oct., on which date there was ice one-fourth inch thick. On 14 Oct., 1897, a single one, the last, was seen and heard on a warm, sunny day, although the first light frost had occurred on 2 Oct. In 1917 the last two were noted on 18 Oct., which was a fine, sunny day after frost, the thermometer in the morning being only 34°F. This is the latest date I have observed it about Halifax. The dates of killing frosts do not seem to determine its latest appearance in a district, as in 1917 they survived fairly severe frosts. It is a lover of sunshine and heat, and during the height of their season a cloudy day will send it into hiding. But very few are seen in the earliest part of the morning, as they are late risers and wait for the sun's heat to energize them, and they disappear as the sunshine withdraws towards the end of the day.

When in flight it produces a loud, sharp snapping or cracking sound, *klip, klip, klip,* repeated usually about five or six times, which is familiar to everyone on a hot summer day. This note seems to be produced by rubbing the under surface of the wing-covers against certain veins on the upper part of the hind-wings. From this sound it is usually called "Cracker" or sometimes "Snapper" by boys and others, it thus being the only species of locust which has been favoured with a distinctive common-name in Nova Scotia. The name "Cracker" is applied to it usually about Halifax, and that name and

"Snapper" are both general in the western counties. It also sometimes flies with a rustling or fluttering sound. When on the ground it is difficult to detect, as its colour harmonizes well with that of its surroundings, but on the wing it at once proclaims itself by its note and the distribution of the yellow on its brightly coloured wings. Its flight is often in a zig-zag course. It does not always wait to be flushed, but is in the habit of taking short flights over its location, cracking as it goes, in pure exuberance of spirits.

I must say I have not much fondness for such a dusty, dirty-looking frequenter of hot, dry highways and other parched and stony places in the full glare of the sun. He delights in such dusty and arid spots, as well as the oily-smelling ballast of breezeless railway cuttings; and the hotter and more sweltering the day, the better he is pleased, the more active he becomes, and the quicker, louder, sharper and more gleefully he cracks his wings, like a man snapping his fingers derisively at the world which disagrees with him. With the ear-piercing note of the Cicada, and in a lesser degree the monotonous preaching of the Red-eyed Vireo from the tree-tops, he is an audible accompaniment and a very symbol of a stiffling noon in the hottest and calmest of the dog-days. At such times one is apt to wonder if there is any region which this insect could find too warm, or what sort of after-punishment, except that of Dante's frozen Lake of Cocytus, would strike salutary terror into evil-doers among these orthopteran knights of the road! Only when he rises from earth, do we catch glimpses of the hidden gold in his sombre make-up.

Subfamily **Locustinæ** (Spine-breasted Locusts). (*Acridinæ* of former writers).

Size variable; *prosternum with a prominent conical spine or tubercle between the front pair of legs;* pronotum not extending over the abdomen, its disk without tubercles or wrinkles,

the hind margin broadly rounded but never acute-angled, median carina low and subequal, the lateral carinæ usually rounded or obsolete; wing-covers usually well developed. This large subfamily may be readily distinguished by the presence of the distinct prosternal spine.—In this subfamily are found our most injurious orthopterans, and it is therefore of the greatest interest to agriculturalists. Oviposition takes place in autumn, and winter is passed in the egg stage from which the nymphs emerge in early summer, and July finds the voracious adults abroad until the end of October sees the last of the pests. The amount of damage caused by them is very considerable, and some species deserve to be closely watched, for in favourable seasons they are liable to occur in unexpected swarms. The damage done to Sable Island by *Melanoplus atlanis* a few years ago, is an example which we should keep well in mind, of what devastation these insects can do when they appear in prodigious numbers. The members of this subfamily rarely stridulate, and then only when at rest, by rubbing the serrated lower inner surface of the hind femora against veins on the outer surface of the wing-covers. There is considerable local variation of colour in the species.

Group Melanopli.*

Key to Nova Scotian Genera of Locustinæ.

a. Wing-covers wanting; interval between mesosternal lobes (those between second or middle pair of legs) distinctly broader than long, as broad or nearly as broad as the lobes themselves; prosternal spine short and conical. (Only of hypothetical occurrence in Nova Scotia) . . . [Podisma, p. 286.]

aa. Wing-covers present, usually well developed but sometimes short, but never wholly wanting; interval between mesosternal lobes longer than broad (not distinctly transverse) . . . . Melanoplus, p. 288.

14. [**Podisma glacialis** (Scudder). Hypothetical occurrence.]

Description.—Form of head and body about as in *Melanoplus*. Face slightly oblique; prosternal spine short and truncate; pronotum faintly constricted in middle in male, and with feebly impressed transverse sulci, its hind margin sub-truncate with a broad but very feeble emargination;

*For an exhaustive account of this group, see S. H. Scudder's Revision of the Orthopteran Group Melanopli (Acridiidæ) with special reference to North America, Proc. U.S. Nat. Mus., vol. 20, Wash., 1898, pp. 1-421, pls. 1-25. The species in the present paper are arranged acco rding to this revision.

interval between mesosternal lobes distinctly transverse (not longer than broad as in *Melanoplus*), as broad or nearly as broad as the lobes themselves; *wing-covers wanting.*

Colour.—The sexes differ somewhat in colour. Dark olivaceous green above, greenish-yellow below. Head yellowish-green with greenish streak down face; pronotum yellowish-green (male) or dark olivaceous-green (female), the lateral lobes bright greenish-yellow below, with principal sulcus black and ending below in a small black spot; above with a broad blackish postocular band which passes along head and pronotum, expanding backward, and continued as transverse streaks on abdomen. Abdomen of male black above with a series of yellowish-green spots and a triangular spot of same between middle and hind coxæ; a lateral row of greenish-yellow spots on first eight abdominal segments; beneath yellowish-green. Abdomen of female olivaceous-green. Hind femora yellowish grass-green, broadly but very obscurely bifasciate with olivaceous-green, under surface and lower half of inner surface coral-red, knee black; hind tibiæ green, the spines (8-11 in outer series) black.

Measurements.—Male: body, 16 mm.; antennæ, 8.5 mm.; hind femora, 9.2 mm. Female: body, 26 mm.; antennæ, 9 mm.; hind femora, 12 mm.

Range.—P. E. Island, Quebec, Sudbury and North Bay in Ont. (variety *canadensis*, etc.), western Maine, northern New Hamp. at high elevations, summit of Greylock in Mass., New York and Penn., usually at high elevations. Canadian Zone.

Remarks.—This species has not yet been reported from Nova Scotia by any collector, but it is here inserted hypothetically as it is very possible that it may occur here rarely and at a few special localities, as Bayard Long on 26 Aug. 1912, took a female of the typical race (*P. glacialis glacialis*) in Kings County, Prince Edward Island, at Dundee "east on the Prince Edward Island railway towards Douglas," in a black-spruce swamp (vide E. M. Walker, Can. Ent., 47, p. 341, 1915). It has also been collected in western Maine and northern New Hampshire at high elevations. Long's records for Prince Edward Island and St. Fabien (Quebec) are the first for the typical race in Canada, although the race *canadensis* had been previously reported by Dr. E. M. Walker.

Podisma is distinctly a boreal type, and its species are, so far as heretofore known, confined to high altitudes as well as high latitudes, although the elevation of Dundee in Prince Edward Island is only 108 ft. on the railway. If *P. glacialis* is in the future found in Nova Scotia, it would most likely be in the more elevated parts, and should be there searched for. Even if met with, it will doubtless be

rare and local in distribution. Scudder observed it frequenting the branches of the Dwarf Birch (*Betula nana*), and says it is rarely or never seen on the ground. It is hoped that these remarks will lead some of our local collectors to search for it.

KEY TO NOVA SCOTIAN SPECIES OF MELANOPLUS AND OTHERS LIABLE TO OCCUR.

Males.

This key refers primarily to males, whose distinctive characters are more pronounced than those of females. As the form of the male cerci, which are to be seen near the end of the abdomen, is an important feature in the separation of species, the student will find it well to refer to the accompanying figure which shows the characterictic forms of those appendages. When the males are distinguished it is much easier to separate the other sex. Females of *femur-rubrum* and *atlanis* present great difficulty in differentiation. The names of species not yet actually reported from Nova Scotia are enclosed in square brackets. A key which is applicable to females follows this one.

a. Wing-covers (except in female of *extremus*) about as long or longer than abdomen.

b. Cerci of male either *equal in breadth or tapering beyond middle*, the tip usually slender or acuminate, never forked.

c. Apex of subgenital plate of male with a small but distinct median *notch;* cerci short and nearly equally broad throughout, not longer than twice the breadth at middle. . 15. *atlanis*, p. 290.

cc. Apex of subgenital plate of male *not notched;* cerci at least three times as long as middle breadth, the apical half sometimes much narrower than basal half (that is, it tapers in form).

d. Hind tibiæ bright red; apical half of male cerci much less than half as broad as extreme base..17. *femur-rubrum*, p. 297.

dd. Hind tibiæ pale red or yellowish; apical half of male cerci distinctly more than half as broad as extreme base; wing-covers not surpassing hind femora, in male reaching nearly tip of abdomen and in female shorter than abdomen (in short-winged form, sometimes called *M. extremus junius*), or else wing-covers surpassing hind femora (in extralimital long-winged form, sometimes called *M. extremus scandens*)............................18. *extremus*, p. 301.

bb. Cerci of male with *apex more or less expanded*, so as to be broader beyond middle, the tip spatulate or sub-spatulate or forked.

f. Size large (male length more than 25 mm.); cerci of male with apical half much enlarged, but *never distinctly forked;* furcula of male small; pronotum with light-coloured (yellow) lateral stripes along margin of disk and continued along wing-covers; hind tibiæ red (yellowish in extra-imital typical *bivittatus*)...19. *bivittatus* (*femoratus*), p. 303.

ff. Size small (male length less than 20 mm.); cerci of male always *forked.*

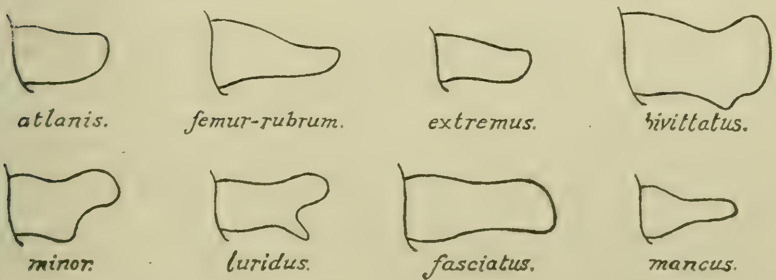
g. Forks of cerci not very pronounced, the lower fork merely an angle or median process; furcula short slender spines. (Not yet reported from N. S.) ...... [*minor*, footnote p. 307.]

gg. Forks of cerci nearly equally distinct and very pronounced; furcula minute triangular lobes. (Not yet reported from N. S.) .... [*luridus*, footnote p. 307.]

aa. Wing-covers much shorter than abdomen.

h. Wing-covers covering two-thirds or more of abdomen, lanceolate, the inner edges overlapping; cerci of male slightly expanded at apex, the middle little narrower than base; furcula minute. (Short-winged phase sometimes called *M. fasciatus curtus.* The long-winged phase is very rare.) (Not yet reported from N. S.).. [16. *fasciatus*, p. 296.]

hh. Wing-covers shorter than pronotum, sub-ovate; cerci of male slender, length about four times middle breadth, the middle about half width of base; furcula well developed but short. (Not yet reported from N. S.) .... [*mancus*, footnote p. 307.]



Distinguishing Forms of Cerci of Males of Species of *Melanoplus.* (Enlarged about 11 times.)

Females.

The following key is a modification of that given by Morse. Species not yet actually reported from Nova Scotia are enclosed in square brackets:

a. Wing-covers much longer than pronotum.
  b. Large, robust; hind femora 15 mm. or more (usually 17 mm.); two distinct yellow stripes on head, pronotum, and wing-covers....... 19. *bivittatus* (*femoratus*), p. 303.
  bb. Smaller; hind femora not over 15 mm.
    c. Dovetailing interspace between mesosternal lobes (between second legs)* longitudinal or quadrate; wing-covers usually passing hind femora; prozona not swollen.
      d. Prosternal spine nearly cylindrical, its tip bluntly rounded; cerci 1½ or 2 times as long as their greatest width, sharply pointed, somewhat acuminate, the converging sides slightly concave......................17. *femur-rubrum*, p. 297.
      dd. Prosternal spine tapering, its tip pointed; cerci shorter, only about 1⅓ times as long as their greatest width, rather blunt at tip, the converging sides straight or convex. 15. *atlanis*, p. 290.
    cc. Dovetailing interspace between mesosternal lobes sub-quadrate or distinctly transverse; wing-covers not passing hind femora; prozona swollen.
      e. Wing-covers about reaching end of hind femora.
        f. Scoop of ovipositor (as seen from side) very short, deeply concave, with a single denticulation or none at base of outer edge; lower valves with tips correspondingly short and decurved; hind tibiæ usually glaucous but sometimes red....... [*minor*, footnote p. 307.]
        ff. Scoop of ovipositor rather long and less deeply concave, the outer edge of basal half rather deeply notched, crenulate-denticulate, the tips of both pairs of valves long and evenly tapering; hind femora coral-red......[*luridus*, footnote p. 307.]
      ee. Wing-covers not reaching end of hind femora, covering about ½ to ¾ of abdomen (but surpassing hind femora in rarer long-winged form).
        g. Dull grayish brown above, clay-yellow below. [16. *fasciatus* (*curtis*), p. 296.]
        gg. Dark greenish yellow, tinged with fuscous. 18. *extremus* (*junius*), p. 301.
aa. Wing-covers shorter than pronotum, sub-oval. .[*mancus*, footnote p. 307.]

15. **Melanoplus atlanis** (Riley). LESSER MIGRATORY LOCUST.

Melanoplus atlanis. Piers, Trans. N. S. Inst. Sc., ix, 215 (1896); Halifax, Cow Bay (Hx. Co.), and Sable Island.—Gooderham, Proc. Ent. Soc. N. S. for 1916, 24, 27 (1917); Col., Cum., Kings, Hants, Ann., Digby, Yar., Queens, Pict., Vict., and Inv. Cos.

*This interspace is a squarish tongue of the metasternum which dovetails forward into the middle posterior part of the mesosternum. It is situated between the second pair of legs.

Description.—Prosternal spine tapering, tip pointed; wing-covers much longer than abdomen (extending one-fourth or more beyond its tip), and surpassing also the hind femora (and thus relatively longer than in *M. femur-rubrum*); *apex of sub-genital plate of male with a distinct, but small, median notch; male cerci short and nearly equally broad throughout, rounded at ends, their length not more than twice the middle breadth* (i. e. cerci not tapering as in *M. femur-rubrum*). These characters make it possible to readily separate the males of this species from those of *M. femur-rubrum*, which otherwise it very closely resembles. Females of the two species are very much more difficult to separate, but the tapering pointed-tipped prosternal spine of the present species will distinguish it from *femur-rubrum* which has a cylindrical prosternal spine with a rounded tip.

Colour.—Much resembles *M. femur-rubrum*. Nova Scotian specimens: Variable; upper parts dark grayish brown (sometimes slightly reddish), under surface of abdomen yellowish; face light sage-green; mouth whitish; a blackish band extending behind the eye on the front lateral part of pronotum and sometimes broken up into small spots, especially in females; wing-covers grayish-brown, distinctly sprinkled with fuscous along the median area; hind femora dirty yellowish-brown or slightly reddish-yellow, with two oblique blackish bars across the upper and outer faces (these bars usually more distinct than in *M. femur-rubrum*); hind tibiæ dull burnt-carmine. (It will be seen that colour alone will not much assist the beginner in differentiating it from *M. femur-rubrum*, and the difference in the structural characters given above should be solely relied upon.)

Measurements.—Male: body, 17-21 mm.; antennæ, 6.5-9 mm.; pronotum, 4-5 mm.; wing-covers, 15-21 mm.; hind femora, 10-13 mm.; hind tibiæ, 8-9 mm. Nova Scotian male, 18 Oct., 1917: body, 18 mm.; antennæ, 6.5 mm.; pronotum, 4.1 mm.; wing-covers, 16 mm.; hind femora, 10.2 mm.; hind tibiæ, 8 mm. Female: body, 16-27 mm.; antennæ, 7-8 mm.; pronotum, 5.5 mm.; wing-covers, 15-22 mm.; hind femora, 10-14 mm. (The relatively longer wings of this species will be noticed in comparison with *M. femur-rubrum.*)

Range.—Most of Canada and United States, into central Mexico: from Sable Island (N. S.), Nova Scotia, P. E. Island, New Bruns., Magdalen Islds., Que., Ont., Man., Alb., Br. Col., and Alaska (Yukon River), south to Georg., Louisiana, central Mex., Ariz., Nev., and Northern Calif. In the east it occurs north to about lat. 50° (exclusive of Nfld.), and on the Pacific to about lat. 62°. It thus is found from the Canadian to the upper parts of the Lower Austral Zone—a range closely approximating to that of *M. femur-rubrum*. It is abundant everywhere in New Eng. and is sometimes destructive there. Has not been found in Newfoundland.

Occurrence in Nova Scotia.—This species was not separated from *M. femur-rubrum* by Riley until 1875, so that any record prior to that may refer to either species. It was first reported from Nova Scotia by Dr. Scudder in 1894 (Rept. Ent. Soc. Ont., 26, p. 64).

This destructive species is apparently rather uncommon about Halifax, being generally very much less numerous than the closely-related *M. femur-rubrum;* whereas in some other parts of the province, as about Truro, it is very abund-

ant. In some years favourable for its rapid multiplication, it has been excessively numerous in certain localities, as for example the notable onslaught in vast hordes which it made on Sable Island, N. S., from 1891 to 1896. Besides my own specimens from Sable Island and about Halifax, *atlanis* has been collected in Inverness, Victoria, Pictou, Cumberland, Colchester, Hants, Annapolis, Digby, Yarmouth and Queens Counties, by C. B. Gooderham, W. H. Whitehead, E. C. Allen and others. It thus occurs throughout the entire province. In Prince Edward Island Mr. Long obtained 39 specimens from ten localities although he only reports six specimens of *M. femur-rubrum*, which would lead one to think it is the more numerous species in that province.

This species (*atlanis*) prefers open grassland in relatively dry situations, and is therefore usually most frequently met on impoverished upland localities (such for example as Camp Hill at Halifax), and it occurs in lesser numbers in the bottoms where the conditions permit the formation of dry grasslands. I have, however, taken it in such a wet boggy locality as the West Marsh, Lawrencetown, Hx. Co., on 26 Oct., 1897. Not unfrequently it is found in company with *M. femur-rubrum*. Supt. R. J. Boutillier states that the young of *atlanis* were observed on Sable Island, N. S., by 28 May, 1896, and that they were a month later than in 1895; but I have never noted them so very early about Halifax. Adults are met with from about the first part of July in some localities, to the latter part of October. The earliest noted at Truro were taken on 30 June and 9 July, 1914; and the latest occurrence, at Lawrencetown, Hx. Co., was on 26 Oct., 1897, a lovely fine day. So far as known, it and *M. femur-rubrum* are found as adults earlier than any other species of our native Orthoptera exclusive of the hibernating Grouse Locusts (*Acrydiinæ*).

M. atlanis is an insect of most destructive possibilites and should be very closely watched, for if it becomes exceed-

ingly numerous, as it is liable to at certain periods, it is capable of producing the greatest devastation to grass and other crops. It is very closely allied to the pernicious migratory Rocky Mountain Locust (*M. spretus*) which once produced stupendous damage in the western United States; and next to that species, Scudder says it is the most destructive locust in America. *M. atlanis*, however, is only sub-migratory in habit, but in certain favourable dry seasons may migrate in large numbers and produce great harm. It is in this migratory ability that the danger lies, for it may suddenly appear in large voracious multitudes. *M. femur-rubrum*, on the other hand, is non-migratory. Sufficient has been said to thoroughly warn agriculturists and economic entomologists to closely watch the Lesser Migratory Locust and to take precautions should it manifest any tendency to increase in numbers in this province. Fortunately on the mainland of Nova Scotia, at least in comparatively recent years, it has not generally occurred in sufficient numbers to do great damage, although the reports as to its abundance about Truro are somewhat disquieting and may indicate that it is the most destructive species in that region. I find as long ago as 7 Sept., 1762, Lieut.-Governor Jonathan Belcher, in a dispatch from Halifax to the Lords of Trade, refers to the loss of crops that year by the drought and grass-hoppers, but it is impossible to say what species or different species were responsible for the damage which called for such a report, although I strongly suspect that a sudden increase in the abundance of the present species was the cause.

By far the worst plague of locusts known to us in this region, at least of late years, was the sudden appearance on Sable Island of myriads of *M. atlanis* which from 1891 to 1896 very rapidly devastated that island which is a hundred statute miles off the nearest part of the eastern coast of Nova Scotia.*

*While Sable Island was thus being devastated by *M. atlanis*, that species was quite uncommon about Halifax, where I was able to find but few specimens although hundreds of *M. femur-rubrum* were taken in hope of finding the other species which closely resembles it.

The earlier stages of this inroad were fully described by me in my paper of 1896 (Trans. N. S. Inst. Sc., ix, 216-218). Up to about 1891 the superintendent of the island had neither seen nor heard of any locusts whatever upon that isolated place. In that year, however, they suddenly made their appearance, having without doubt flown from the mainland, a distance, as has been said, of a hundred miles or more, their powers of flight being great and the prevailing southwest wind no doubt assisting them in their long journey. Their numbers very soon increased at a most alarming rate, the summer of 1892 being a dry one.* So destructive did they become by vigorously attacking the grass, that in 1894 which was the dryest season on record, only one load of hay could be cut where fourteen had previously been harvested. It was said they devoured the grass near the root. This was a most serious matter, for if the grass should disappear, nothing could prevent the wind from rapidly shifting the sand of which the island is entirely formed, and this would ultimately result, unless extraordinary and costly preventive measures were taken, in that oceanic sandbank disappearing beneath the sea, causing an already dangerous spot to become vastly more perilous to shipping. In 1895 the insects were more abundant than ever, particularly on the western parts. and destroyed the gardens as well as the cultivated and wild grass, and hay had to be imported to support the herds of wild ponies, while more of the latter had to be sent to the mainland to reduce the stock which required feeding. The locusts were swept up in bucketsful from the doorsteps, and they even entered a room and destroyed portions of a cotton window-blind. Many had disappeared for the season by 12 Oct., 1895, and a letter dated 10 Nov. stated they were by that time all dead, although in 1894 they survived very

*In 1888 the precipitation in July, Aug., and Sept. was above normal; in 1889 the same months were dry, it being a very dry year altogether; in 1890 July was below normal, and Aug. and Sept. above normal; in 1891 July was above normal and Aug. and Sept. below; 1892 was dry in July and Sept. and somewhat wet in Aug.; in 1893 the three months were wet; in 1894 they were very dry, it being an excessively dry year; 1895 was fairly wet, and 1896 was excessively wet.

cold weather if not frost. An examination of very large numbers of the locusts sent me in November, 1895, proved that *M. atlanis* was the sole species represented on the island and the specimens were mostly females.

In a letter dated 28 May, 1896, the superintendent of the island informed me that "the locusts are with us again, but are a month later than last year (1895). The season, however, is that much later, very cold and backward, and vegetation greatly retarded. The young have appeared as yet only at the east end of the island, whereas they were much more plentiful at the west end last year." On 11 June, 1896, the young locusts appeared in millions, following a warm spell of weather, and the prospect seemed very bad as no method had been adopted to keep them in check. Most providentially, however, the year 1896 turned out to be as excessively wet as 1894 had been excessively dry, and the mild weather was succeeded by a fortnight of cold rains which destroyed the young insects, and they thus disappeared even more suddenly than they had appeared in 1891. Since 1896 no locusts have been seen on the island, much to the relief of the authorities in charge of the establishment there, among whom the plague had naturally created great consternation. Such an inroad, however, is quite liable to reoccur under similar conditions, and possibly the *deus ex machina*, in the guise of bad weather, may not then providentially interpose to end the menace before irretrievable damage is done.

I am aware of no such plague on the mainland of Nova Scotia, but there is no reason why a similar one should not occur here at any time, under the necessary favourable conditions, although the natural enemies of such insects are more likely to be met with on the mainland than on an isolated spot such as Sable Island where locusts had not previously been reported. Belcher's reference to the destruction of crops by locusts in 1762, which has been mentioned,

may refer to a somewhat similar increase in numbers in Nova Scotia proper. There can be no doubt that this species, wherever found, must be watched as a suspected hereditary criminal, whose latent destructive propensities may break forth whenever conditions are favorable for abnormal multiplication, whereby it is endowed with immense collective power for ill-doing.

As to preventive measures, Somes (Acridiidæ of Minnesota, 1914) recommends as a real cure for these pests a thorough method of cultivation of the land, with a rotation system in which a thoroughly cultivated crop shall always follow cereals; although temporary relief may be obtained by spraying with sodium-arsenite, and the use of hopper-dozers. No doubt the poison bait and deep ploughing as recommended under *M. femur-rubrum* would be better suited to conditions in Nova Scotia.

16. [**Melanoplus fasciatus** (Barnston-Walker). Hypothetical occurrence.]

Description.—Size medium. Wing-covers in the usual short-winged form (sometimes called *curtus*) much shorter (length about 10 mm.) than the abdomen (covering about three-fourths in male, and about one-half in female) and from 1½ to 2½ times as long as the pronotum, their form lanceolate, the inner edges overlapping. Subgenital plate of male distinctly narrower than long, its extremity strongly elevated; cerci of male nearly straight, slightly expanded at apex, the middle but little narrower than extreme base; furcula of male short, no longer than last abdominal segment to which it is attached.

Colour.—Variable; dark reddish-brown to dark olivaceous-gray or grayish-brown, the male darker; below yellow. A well-marked blackish band from behind eye along upper part of side of anterior part (prozona) of pronotum. Wing-covers reddish-brown, often with a few small dark spots on median area. Hind femora brownish-yellow, the outer face with two broad, oblique, blackish bars, the lower face reddish, knees black; hind tibiæ red or greenish, paler near base, spines black

Measurements.—Male: body, 16-19 mm.; antennæ, 8-9 mm.; pronotum, 4.5 mm.; wing-covers, 7.5-10 mm. (form *curtus*); hind femora, 10 mm. Female: body, 17-25 mm.; antennæ, 7-8 mm.; pronotum, 5mm.; wing-covers, 8-12 mm. (form *curtus*); hind femora, 11-15 mm. In the very rare long-winged form, *volaticus*, the wing-covers measure about 17 mm. In the Magdalen Islands, Dr. E. M. Walker (B. Long coll.) reports large specimens, the males of which vary in length of body from 19-23 mm.; wing-covers, 11-14 mm.; hind femora, 11.5-12.5 mm.; and the females, body, 24.5-28.5 mm.; wing-covers, 6.5-19.5 mm.; hind femora, 12.5-13.5 mm. The Newfoundland specimens are also very robust for the species, and do not show the brilliant type of coloration sometimes found.

Range.—Canada and northern half of United States from Atlantic to Pacific: from Bay St. George (Nfld.), Nain (Labrador), Anticosti, Magdalen Islds., P. E. Island, Ont., Man., Sask., Alb., and perhaps Alaska, south to New Jers., northern Ind., Iowa, Nebr., Mont., and Wash. Terr. It is thus distributed from the southern portion of the Hudsonian Zone to the high northernmost portion of the Upper Austral.

Remarks.—Although this distinctly northern form has not yet been reported from Nova Scotia, there can be no doubt whatever that it will be found here and I do not hesitate to insert it hypothetically in our list. It should be looked for among low bushes in sandy districts. Bayard Long obtained five specimens of the short-winged form at Dundee and West River, Bothwell, Prince Edward Island, late in August, 1912 (E. M. Walker, Can. Ent., 47, p. 341, 1915), and it has been reported from Bay St. George in Newfoundland (M. Hebard, 1915) and Labrador, while it is common throughout New England. The Prince Edward Island and Newfoundland specimens were all of the short-winged form, sometimes called *M. fasciatus curtus* Scudder (1879), which is the form which should occur here. The very rare long-winged form sometimes known as *M. fasciatus volaticus* Scudder, in which the wing-covers are broad and far surpass the hind femora (length 17 mm.), has hitherto only been known from Michigan, although Dr. E. M. Walker has lately reported it from Alright Island in the Magdalen Islands (Can. Ent., 47, p. 342, 1915).

17. **Melanoplus femur-rubrum** (De Geer). RED-LEGGED LOCUST.

Caloptenus femur-rubrum. F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 678 (1870); Nova Scotia, etc.—Do., Can. Ent., iv, 30 (1872); Nova Scotia, etc.

Melanoplus femur-rubrum. Piers, Trans. N. S. Inst. Sc., ix, 215 (1896); Halifax and Windsor, N. S.—Gooderham, Proc. Ent. Soc. N. S. for 1916, 24, 27 (1917); Col., Cum., Kings, Hants, Ann., Digby, Yar., Queens, Pict., Vict., and Inver. Cos.

Description.—Prosternal spine nearly cylindrical, the tip bluntly rounded; wing-covers somewhat longer than abdomen, slightly surpassing tip of hind femora; *apex of subgenital plate entire* (not notched); *male cerci at least three times as long as its middle breadth, the apical half less than half as broad as its extreme base* (i. e., cerci broad at base and markedly tapering at end).

Colour.—Nova Scotian specimens. Variable; usually brownish above; tea-green (greenish olive-gray) or olivaceous on front and sides of head and thorax; sides and under surface of abdomen mostly dirty cream-white or grayish; a yellowish line on side of thorax from insertion of wing-cover to insertion of hind leg; a broad black bar extends from eye backward onto lateral front part of pronotum, often inconspicuous in female. Wing-covers hair-brown to broccoli-brown, usually very obscurely spotted with fuscous along basal half of median area. Hind femora raw-umber brown, clouded with dark fuscous which usually forms two oblique bars on upper edge; lower edge yellowish with pale poppy-red on outer part of edge; knee black. Hind tibiæ almost always poppy-red; spines black. Occasionally a specimen is found whose general colour is yellowish olive-buff, and the markings much paler than in normal specimens.

Measurements.—Male: body, 16-23 mm.; antennæ, 7-10 mm.; pronotum, 4.5 mm.; wing-covers, 13-20 mm.; hind femora, 11-13 mm. Nova Scotian males, 21-28 Oct., 1917: body, 20-21 mm.; antennæ, 8-9 mm.; pronotum, 4.3 mm.; wing-covers, 16-16.5 mm.; hind femora, 11 mm.; hind tibiæ, 9-9.5 mm. Female: body, 18-28 mm.; antennæ, 7-9 mm.; pronotum, 5 mm.; wing-covers, 16-23 mm.; hind femora, 11-15 mm.

Range.—This very common species ranges over most of Canada and the United States into central Mexico: from P. E. Island, Nova Scotia, New Bruns., Que., Ont., Man., and Br. Columbia, south to N. Car., Tenn., Miss., Texas, central Mexico, Ariz., Nev., and southern Calif. It thus occurs from the Canadian to the upper part of the Lower Austral Zone—a very extensive range which is also about that of *M. atlanis*. It is exceedingly abundant everywhere in New Eng. It has not been found in Newfoundland.

Occurrence in Nova Scotia.—The Red-legged Locust was first reported from Nova Scotia by F. Walker in 1870, from specimens collected no doubt by Lieut. Redman, probably about 1821. Although at that time *M. atlanis* had not been differentiated from it, yet the greater abundance of *M. femur-rubrum* about Halifax makes it fairly clear that the latter species was referred to.

This species is excessively abundant about Halifax, where it is probably our most common orthopteran exclusive of the Crickets; and it is more or less common elsewhere throughout the province. It has been observed by C. B. Gooderham, myself and others in Inverness, Victoria, Pictou, Cumberland, Colchester, Hants, Halifax, Kings, Annapolis, Digby, Yarmouth and Queens Counties, and I think I have

also taken it in Lunenburg County. About Truro, Col. Co., Gooderham reports it as common, whereas he says *M. atlanis* is there more abundant, the conditions being the reverse of those about Halifax. It is found in large numbers in pastures and meadows, where it scatters in all directions from the feet of a passer-by; and also along roadsides. It avoides dense herbaceous thickets and woodland, and favours open grasslands and clover fields, and very often such as are quite dry. Large numbers seen about short sparsely-bladed grass, suggest that they have destroyed the herbage in such cases. About Windsor, Hants Co. and Kentville, Kings Co., I have observed it on the diked meadows. When disturbed it either hops away or else flies swiftly and noselessly ahead for some distance and then drops to the grass again.

It occurs in the perfect state from the first to the latter part of July, according to locality (7 July, 1915, and 9 July, 1914, Truro; 31 July, 1917, Hubbards), until about 24 October (20 Oct., 1895, 24 Oct., 1897, and several 28 Oct., 1917 Halifax), although in October, particularly in the latter part, it is much less frequently seen. Its last appearance is a month after the first hoar-frost which usually occurs throughout the province about 20 September, and a little after the first hard frost which generally occurs about 16 October. Thus hard frosts soon terminate its existence. It, *M. atlanis*, *M. extremus*, and *Chorthippus curtipennis*, are the earliest of our species to be met with in the adult state, exclusive of the hibernating Grouse Locusts (*Acrydiinæ*).

This species, like the closely related *M. atlanis*, is one of the most destructive locusts in Nova Scotia. About Halifax, because of its predominate numbers, it is probably the one which does the most damage in our fields; whereas in the western part of the province, the sub-migratory *atlanis*, owing to its reported prevalence there, would be entitled to that unenviable reputation. The capabilities of *atlanis* to do injury are probably the greater. The onslaught on

Sable Island is an illustration of what havoc the latter species is capable of doing. Were it possible to calculate the damage done by these two locusts, we would be somewhat astounded. I do not believe, however, that any of our species do quite as much injury as in more southern regions, possibly owing to the comparative severity of some of our winters which is apt to destroy many eggs. Even under favourable conditions for their increase, they are so subject to the attack of parasites and other enemies, as well as the influence of various climatic changes, that their natural increase is restricted. Were it otherwise we would have to regard some of the locusts as a very much more serious pest than they are in Nova Scotia. In the case of *femur-rubrum* it is also fortunate that the species is not a migratory one, whereas *M. atlanis* is submigratory. M. P. Somes, however, has observed in Minnesota (Acridiidæ of Minn., Bulletin 141, Agric. Exp. Station, Minn., p. 85, 1914) that during dry summers the majority of specimens of *M. femur-rubrum* had longer wing-covers than normal, and in many cases fully as long, relatively, as in *M. atlanis*, accompanied with an instinctive inclination for more extended flights late in the summer; which led him to wonder if a prolonged series of dry seasons might not produce a more nearly migratory form in these two species, especially in the case of *M. atlanis* which would then become almost identical in this respect with the very destructive Rocky Mountain Locust, *M. spretus*, which in the past has done millions of dollars worth of damage in the western United States.

As to remedial measures, ploughing to a depth of at least six inches in late autumn or very early spring, will more deeply bury many of the egg-pods and so prevent the young escaping to the surface in the spring. The following poisoned bait has been successfuly employed in eastern Canada, but should be used with caution on pastures where cattle feed or where fowls are apt to roam: Poisoned Bran,—bran, 20

lbs.; Paris green or white arsenic, 1 lb.; molasses, 2 quarts; the juice and finely cut-up pulp and peel of 3 oranges or lemons; water, 3½ gals. The bran and arsenic are thoroughly mixed while dry, while the orange juice, molasses and water are mixed separately and then added to the bran and poison mixture so as to dampen it thoroughly. It is then sown broadcast and very thinly over the infested area early in the morning. The amount given above will cover five acres. It should be applied co-operatively, at the same time, by the farmers of a district in order to be really effective. The cost is about 20 cents an acre at the price of ingredients in 1914, but just now would be considerably more.

This species, like *M. bivittatus*, is attacked by a coral-red parasite, which is doubtless the Red Locust-mite, *Trombidium locustarum* Riley, which attaches itself to the insect beneath the base of the wings. A specimen taken at Hubbards, Hx. Co., 31 July, 1917, had six or seven of these parasites upon it.

18. **Melanoplus extremus** (F. Walker). (Short-winged form.)

Melanoplus extremus. Gooderham, Proc. Ent. Soc. N. S. for 1916, 24, 27 (1917); Col. and Kings Cos.

Description.—Wing-covers either (a) not reaching tips of hind femora, being about 11 mm. long, and reaching about end of abdomen in male and covering usually from half to three-quarters of abdomen in female, bluntly subacuminate at apex (short-winged form sometimes called *M. extremus junius* Dodge), or (b) wing-covers surpassing tips of hind femora, generally considerably, being about 17 mm. long, and rather broadly rounded at apex (long-winged form, sometimes called *M. extremus scandens* Scudder). In the former the wings are considerably shorter than the wing-covers, and in the latter form they are very little shorter than those members. Apex of subgenital plate in male without a median notch; cerci of male short and broad, the apical half distinctly more than half as broad as the extreme base, gently curved, well rounded at tip; furcula a pair of parallel, tapering, cylindrical spines, about half as long as supra-anal plate.

Colour.—Dark greenish-yellow, more or less fuscous. A black bar from behind eye and along anterior part (prozona) of sides of pronotum; pronotum olive-brown above, greenish-yellow on sides. Wing-covers olive-brown, sometimes with a few dark spots on median area. Hind femora yellowish tinged with red-brown, lower face usually light orange, knees darkish; hind tibiæ reddish or yellowish, with black spines.

Measurements.—Male: body, 16-24 mm.; antennæ, 8-9 mm.; pronotum, 4 mm.; wing-covers, about 11 mm. (*M. e. junius*) to about 16 mm. (*M. e.*

scandens); hind femora, 10 mm. Female: body, 19-28 mm.; pronotum, 5 mm.; wing-covers, about 11 mm. (*M. e. junius*) to about 17 mm. (*M. e. scandens*); hind femora, about 11mm. (Short-winged specimens of extremely large size, males with bodies up to 24 mm., and females up to 28 mm., with corresponding increase in size of wing-covers, hind femora, etc., have been lately recorded by Dr. E. M. Walker from the Magdalen Islands. Northern specimens of this species are distinctly larger than more southern ones.)

Range.—M. extremus in either its short or long-winged form or both, ranges over the larger part of Canada and northernmost United States: from P. E. Island (both short- and long-winged forms), Nova Scotia (short-winged form), New Bruns. (short-winged form), Magdalen Islds. (short-winged form,) Bic (Quebec, both forms), Alb , Gt. Bear Lake (about lat. 65°), and Alaska (lat. 66° 30′), south to Mass., Ind., Ill., Iowa, Neb., and Wyom. It is confined more or less to the Hudsonian, Canadian, and Transition Zones, ranging further north in the west than in the east. In the northern half of New England it is common, and reaches the summits of the highest mountains.

Occurrence in Nova Scotia.—Only the short-winged form (sometimes called *M. extremus junius* Dodge) has so far been detected in Nova Scotia, although the long-winged one should also occur and no doubt will yet be met with. The species has not before been reported from this province, and the credit of adding it to our list belongs to C. B. Gooderham who collected three short-winged females at Truro, Col. Co., on 28 July, 1913, and 5 July, 1914, their determination being verified by Dr. E. M. Walker of Toronto. He also reports a female taken by G. F. Collingwood in Kings County, N. S., but when received it had no precise data as to exact place where captured or date. He likewise has a short-winged female collected at Hillsboro, in the neighbouring province of New Brunswick, on 8 Aug., 1913, by Miss V. L. Tarris, from which province it has also not previously been reported. He considers it rare about Truro, and I have never noted it about Halifax. From its known range, this boreal species was to have been expected to occur here, as B. Long had taken three specimens in Prince Edward Island in the summer of 1912, namely a short- (*junius*) and a long-winged (*scandens*) male at Souris, and a short-winged female at Southport (E. M. Walker, Can. Ent., 47, p. 342, 1915). The long-winged form is probably more frequently met with at high elevations as well as high latitudes.

19. **Melanoplus bivittatus** (Say). YELLOW-STRIPED LOCUST. (Red-legged phase, sometimes called *M. bivittatus femoratus* (Burmeister)).

Caloptenus bivittatus. F. Walker, Cat. Derm. Salt. Brit. Mus., iv, 678 (1870); Nova Scotia, etc.—Do., Can. Ent., iv, 30 (1872); Nova Scotia, etc.

Melanoplus femoratus. Piers, Trans. N. S. Inst. Sc., ix, 218 (1896); Halifax Co.

Melanoplus bivittatus Gooderham, Proc. Ent. Soc. N. S. for 1916, 24, 27 (1917); Col., Kings, Hants Ann., Yar.. Queens, Vict., and Inver. Cos.

Description.—Our largest species of *Melanoplus.* Wing-covers reaching or a little surpassing the hind femora, sometimes a little shorter in female. *Cerci of male large, wide, with the apical half much expanded,* but not forked, somewhat boot-shaped with wide "toe" and a distinct, but somewhat small, protuberant "heel"; furcula short, swollen, triangular.

Colour.—Nova Scotian specimens (red-legged phase). The very distinctive colouring of this familiar locust makes it impossible to confuse it with any other species found here. General colour above bright apple-green (but occasionally grayish olive-green); under parts yellowish. Antennæ reddish-brown; mouth straw-yellow (occasionally pale clay-colour); eyes brown. *A very distinct sulphur-yellow* (occasionally paler Naples-yellow) *line* extends on each side from upper part of eye along lateral angle of pronotum and thence, as a less pure yellow (maize-yellow or buff) line, along the anal vein of the wing-cover to near the latter's extremity; this stripe bordered below by a wider, almost black band on head behind eye and on upper side of pronotum, being widest on front part of latter. A diagonal sulphur-yellow stripe on side of metathorax from insertion of wing-cover to insertion of hind leg. Wing-covers hair-brown, sometimes blacker; hind-wings transparent with veins mostly brownish. Hind femora greenish-black on upper half of outer face, extending to knee where it is darkest; outer face margined with yellow (occasionally pale buff); upper inner margin with three black spots or short bars; a black ring near knee. Hind tibiæ poppy-red or nopal-red (intermediate between vermilion and carmine), dusky at base; spines black: hind feet red. (In the extralimital colour variant, *M. b. bivittatus* of Say, the hind tibiæ are purplish or green basally, and yellow, very rarely reddish, apically).—Colour from 3 males and 3 females, just captured among meadow-sweet (*Spiræa latifolia*) and grass, near Willow Park, Halifax, N. S., 17 Aug., 1895. Only one of these, a female, taken with the others, showed the more olivaceous and less striking colours noted above as occasionally occurring. All had bright red hind tibiæ.

Measurements.—Three males and three females, Halifax, 17 Aug., 1895. Male: body, 26.5-28 (average 27) mm.; antennæ, 13 mm.; wing-covers, 18.5-21.2 (average 19.4) mm.; wing-covers extend beyond body, 0-2.5 (average 1.2) mm.; hind femora, 14-15.2 (average 14.5) mm.; hind tibiæ, 11.5 mm. Female: body, 31-35 (average 33) mm.; antennæ, 11.5 mm.; wing-covers, 19.7-21.5 (average 20.7) mm.; wing-covers short of end of body, .7-5.5 (average 3) mm.; hind femora, 15.2-18.7 (average 17) mm.; hind tibiæ, 13-15 (average

14.2) mm. I have taken females which have measured 40 mm. in total length, and probably still longer ones can be met with.

Range.—*Melanoplus bivittatus* ranges generally from near Hudson Bay to N. Car. and Calif., and from the Atlantic to the Pacific.—The red-legged phase (*M. b. femoratus*) which is said to be a seaboard and northern colour-phase, occurs from Newfoundland (Port aux Basques, Hebard), P. E. Isld., Nova Scotia, Quebec, Ont., Man., and Br. Columbia, south through New Eng. to N. Car., Ind., Ill., Colo., and Calif., it being the only variant found along the Atlantic seaboard and the Pacific slope south of Washington. This phase therefore ranges from the Canadian (or a little beyond) to probably the upper Austral Zone.—The typical phase (*M. b. bivittatus*) is of interior distribution, ranging probably from southern-central and western Canada to the Gulf of Mexico, being unknown on the Atlantic seaboard and the Pacific coast south of Washington. The ranges of the two forms therefore overlap in the central region of the continent.

Remarks.—The late Dr. Scudder always held that *femoratus* was specifically distinct from *bivittatus*, contending that the former is a seaboard and northern species, while the latter is an interior one, the ranges of the two overlapping in the central areas, and he so treated them as distinct in his exhaustive "Revision of the Melanopli" (Proc. U. S. Nat. Mus., 20, 1898) for reasons there stated. He continued to maintain this, I think, until the last, *M. femoratus* appearing as a separate species in his "Catalogue of Described Orthoptera" (1901). Blatchley of Indiana (1903), Walden of Connecticut (1911), Somes of Minnesota (1914), and many others, particularly those of the central portions where the two ranges overlap, consider them to be but trivial colour-phases of the same species, the differences being of little diagnostic value. While going with recent opinion in this, we may for the present retain the name *femoratus* as a mere varietal appellation conveniently indicating the colour variant which is found here.

Occurrence in Nova Scotia.—The very well known Red-legged Yellow-striped Locust, one of our largest orthopterans, was first reported from Nova Scotia, as *Caloptenus bivittatus*, by F. Walker of the British Museum in 1870, no doubt from specimens collected about 1821 by Lieut. Redman (Cat. Derm. Salt., 4, p. 678).

Only the colour-phase *femoratus*, with bright red tibiæ, is found here. All specimens in the collection of the Agricultural College, Truro, have bright coral-red tibiæ except one in which they are black passing into bright red less than half-way down, and this may be owing to discoloration after being placed in the cabinet. Mr. Gooderham says his examples from Colchester, Annapolis and Yarmouth Counties all have red or purplish tibiæ. All the specimens I have observed about Halifax, also have these members red, as well as others I have seen from Hants, Kings, and Yarmouth

Counties. So likewise had those taken in Prince Edward Island and at Moncton, N. B., by B. Long in 1912.

This form is very common throughout the entire province, but varies somewhat in abundance according to the climatic condition of the seasons, being some years less abundant than in others. It has been taken by Gooderham, myself and others in the following counties: Inverness, Victoria, Colchester, Hants, Halifax, Kings, Annapolis, Yarmouth, and Queens, and I think I have also observed it in Pictou and Lunenburg Counties. As it is common in the vicinity of dwellings, it is well known by sight to residents in rural districts, although strange to say I have never heard a distinctive common-name applied to it here, except the indefinite general term "grasshopper" which it shares with all other related species. It may, however, be considered "the grasshopper" of most country children's vocabulary; and is usually the one referred to when the descriptive designation "molasses bug" is once in a while used by the little generation, for a reason which we will refer to later.

It occurs in long grass in meadows, being frequently seen among the swaths at haying time, but leaves the open meadow after the grass is cut, and then frequents the uncultivated borders. It is very fond of the rank succulent vegetation which flourishes on the margins of fields, and frequents the vicinity of the Wrinkle-leaved Goldenrod (*Solidago rugosa*), and at times seems partial to Meadowsweet (*Spiræa latifolia*). Very many have been observed early in September on the Low Blackberry or Dewberry (*Rubus canadensis*). I have also frequently observed it in marshy grass. Large numbers were seen in the middle of October about a variety of herbage on the borders of Stanford's Pond, Halifax, then dried up. When abundant it occasionally enters gardens and attacks their contents. On being disturbed it tries to escape by hopping, seldom taking to flight, and is generally a very clumsy and rather slothful species. Its

appearance and movements have a lack of elegance which makes it less attractive than many of our locusts, although it is decisively and somewhat handsomely bedecked with colours.

It hatches in the latter part of June, as I have collected the green-coloured nymphs, about 9 mm. long, in the second stage, before the appearance of the wing-pads, on 1st July, 1917, in grass at the head of the North West Arm, Halifax, and others 14 mm. long, in about the fourth stage with wing-pads 2 mm. long, at the same place on 8th July. Adults are noted from about the latter part of July (22 July, Truro; 1 Aug. '17, Hubbards, Hx. Co.) until toward the end of October (20 Oct. '95; 26 Oct. '97, 27 Oct. '17, Halifax). The first hard frosts which begin to occur about the 16 Oct. soon put an end to any but lingering stragglers, although an occasional individual may possibly considerably prolong its existence by getting into some warm crevice about a barn to reappear under the influence of a warm day. It seems to be a silent species.

No doubt this locust does very considerable damage in the aggregate in Nova Scotia, more particularly to hay-crops; but so far it does not seem to have called loudly for repression. Next, however, to *M. femur-rubrum* and *M. atlanis*, and the Crickets, it is one of the most destructive species of Orthoptera we have as far as grass, grain, and other cultivated crops are concerned; and with them it deserves watching. After a series of favourable dry seasons, which have permitted it, as well as other species, to increase rapidly, it becomes most numerous and occasions much loss; but then there usually follows a period when it dwindles much in numbers from natural causes; so that it is only occasionally the farmer views it with much concern. It is said to be subject to the attack of a fungi in wet seasons, as well as other parasites, besides various vertebrate enemies. In the middle of August, 1895, and on other occasions, I have collected

specimens with from two to a dozen minute, egg-shaped, coral-red parasites about half of a millimeter in length, beneath the base of the hind wings. These were doubtless the Red Locust-mite, *Trombidium locustarum* of Riley.

Near the mouth opening of insects are salivary glands which in the *Acrididæ* usually secrete a brown-coloured fluid, which is also probably defensive in character as many species when captured very readily exude it from the mouth. This is particularly noticeable in the present species, and country children have everywhere given the dark-coloured secretion the name of "grasshopper molasses" and to the insect itself they occasionally apply the name "molasses bug". This species is often captured by Nova Scotian children for the sole purpose of seeing it exude the fluid, their invariable saying on such an occasion being, "Grasshopper, grasshopper, give me some molasses and I'll let you go." It is also known to many children as a doughty fighter, boys often amusing themselves by bringing two large specimens together so that they wrestle vigorously with their front legs and endeavour to bite each other. These gay-coloured locusts bring back childish memories of half-forgotten summer days when we dallied waist-deep in the lush timothy, the air filled with what might be termed the "green" scent of trampled grass; or of afternoons in early autumn when we loafed about the rank vegetation of fence-rows with its odour of dank decay.*

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*The following *Melanopli* are more or less abundant in northern New England, and one or two of them may be taken here:—

Melanoplus mancus (Smith) occurs locally in elevated (2,000 to 3,500 ft.) localities in Maine, New Hamp., and Conn., etc.; but has not been taken in Canada. Wing-covers shorter than pronotum, and subovate. Male cerci slender, clasp-like, about four times as long as middle breadth, the middle breadth less than half of extreme basal breadth. General colour fuscous. Length, male 14-17 mm.; female, 18-25 mm.

Melanoplus minor (Scudder) is common in New England north to Maine, and has been taken in Ont. and Sask., and we should expect it here. Wing-covers reach the knees. Male cerci with apex expanded and somewhat forked, the lower branch of fork merely an angle or median projection on the lower edge. General colour brownish, yellowish below, black bar behind eye; hind femora brownish-yellow with indistinct darker bars, their lower face generally orange. Length, male, 15-18 mm.; female, 19-24 mm.

Melanoplus luridus (Dodge) = *M. collinus* Scudder. Blatchley has shown that these names are synonymous, or the later merely varietal. Scudder reported *M. collinus* as common in New England north to Maine, and Walker found it in Ont. Wing-covers reach, or slightly surpass, the knees. Male cerci expanded at apex and very distinctly forked. In colour and appearance it resembles *M. femur-rubrum*, but wing-covers are much shorter, and the forked cerci distinguish it immediately. Length, male, 17-20 mm.; female, 20-27 mm.

Family TETTIGONIIDÆ (Long-horned Grasshoppers, Katydids, Camel Crickets, etc.)
(*Locustidæ* of former writers.)

This family is easily separated from the *Acrididæ* by the *long bristle-shaped antennæ*, which are much longer than the body, and the long ovipositor of the female; while from the *Gryllidæ* it is distinguished by the *four-jointed tarsi* and the sloping sides of the wing-cover which meet in an acute ridge above. The ovipositor forms a strongly compressed, elongated, generally sword-shaped blade, the tip not expanded. The stridulating or calling organs of the male, when present in the winged species*, are situated just behind the pronotum, at the base of the sub-triangular overlapping dorsal area of the wing-covers, and usually consist of a transparent resonant membrane of somewhat rounded form, crossed by a prominent curved vein which on its under side bears a row of minute file-like teeth. In stridulating, the wing-covers are parted and then brought together again, thus rasping these teeth over a vein on the upper surface of the under wing-cover, and so producing the loud strident call which is such a typical nocturnal sound in the country. These notes differ in different species, and somewhat resemble the word "katydid" in the true Katydid, *Cyrtophyllus perspicillatus*, which does not occur in this province. In our own species, however, the note has no resemblance whatever to that sound. The mandibles are well developed, which enables the insect to dig into plant tissue and eat grass seeds as many of them do; and being greedy feeders they produce considerable damage to vegetation, but fortunately mostly of the uncultivated kinds. The manner of oviposition differs in the various subfamilies: in the *Phaneropterinæ*, which are arboreal, the eggs are usually attached in double rows to the exterior of small twigs, or are inserted in the edges of leaves, and the ovipositor is

*The Stone Crickets (*Stenopelmatinæ*) are wingless and therefore silent.

broad, curved and blunt; in the *Conocephalinæ*, which are mostly terrestrial, the eggs are deposited by a piercer-like ovipositor between the stems and root-leaves of grass or in the pith of twigs, etc.; while in the terrestrial *Stenopelmatinæ* they are doubtless placed in the ground. The eggs usually, and in Nova Scotia doubtless always, remain in the place of oviposition over winter and hatch the next season, the young at first being wingless and arriving at maturity after the usual five months.

KEY TO NOVA SCOTIAN SUBFAMILIES OF TETTIGONIIDÆ.

a. Wing-covers and wings present.

b. *Prosternum* (*under surface of thorax*) *without spines;* vertex of head rounded or deflected; wing-covers rather broad, leaf-shaped, and of a bright green colour, always shorter than the wings. (Mostly found on shrubs.)....................PHANEROPTERINÆ, p. 309.

bb. *Prosternum with spines* (very short and weak in our genus *Xiphidium*, but longer and more slender in genus *Orchelimum* which may occur here); wing-covers narrow, expanded little if any in middle, often shorter than wings; vertex terminating in a rounded tubercle in our species, (and in a long cone in extralimital ones); pronotum without or with only one transverse sulcus; ovipositor slender and nearly straight in our genus *Xiphidium*, (but stout and upcurved in *Orchelimum*). (Mostly terrestrial.)..CONOCEPHALINÆ, p. 323.

aa. Wing covers and wings wholly absent; pronotum short, not covering whole top of thorax; prosternal spines absent; ovipositor nearly straight. (Occurring under stones, etc.)..........STENOPELMATINÆ, p. 325.

Subfamily **Phaneropterinæ** (Katydids, in part).

Vertex of head rounded, without cone or spine; *prosternum without spines, wing-covers and wings present*, the former rather broad, of a bright green and closely resembling a leaf in form and colour, the wings large and extending beyond the covers. The species live chiefly on bushes and small trees, with the foliage of which they remarkably harmonize; they are solitary in habit and slow in movement, and while some kinds are quite numerous yet they so completely blend with their surroundings that they are very rarely seen except by the naturalist. They differ in manner of oviposition from other *Tettigoniidæ*. The eggs instead of being deposited in the earth or in twigs, are usually glued in double rows to the outer surface of slender twigs, or are

inserted in the edges of leaves; and for such use the ovipositor is broad, curved and obtuse at the apex.—Only one genus, *Scudderia*, is represented in Nova Scotia, it being distinguished by having the wing-covers of nearly equal breadth throughout, and by the fastigium of the vertex being no broader than the first antennal joint.

Group Scudderiæ.*

Key to Nova Scotian Species of Scudderia (males).

Note.—The upper anal appendage of the male must be carefully examined with a lens in order to identify the species, the female being extremely difficult to separate, but, fortunately for the beginner, the latter is much less often met with. The chief member used for identification, is what is called the supra-anal spine of the male, a produced pistillate process on the upper part of the last abdominal segment. There is also a long sub-anal spine which curves upward past the end of the supra-anal process, but it is not used for diagnostic purposes.

Last abdominal segment with a median produced pistillate process on its dorsal side (supra-anal spine), this process forked at its apex, with no median projection in the concavity of the fork.

a. Forked branches of supra-anal spine lobate; these lobes or lateral processes bearing small vertical longitudinal *flanges or keels* along their lower surface; *notch of supra-anal spine shallow and acute* (V-shaped).

- b. Lobes (or lateral processes) of forked part of supra-anal spine distinctly *tapering toward their ends* when viewed from above; wing-covers relatively *broad* and short, their length about 3 times their greatest width............................20. *pistillata*, p. 312.
- bb. Lobes of forked part of supra-anal spine *sub-equal in width* when viewed from above; wing-covers proportionately *narrower*, their length about 4¼ times their greatest width in male, and about 4½ times in female..............21. *curvicauda borealis*, p. 317.

aa. Forked branches of supra-anal spine lobate; these lobes or lateral processes *not bearing longitudinal flanges* along their lower surface, and not much longer than broad; they are decidedly *swollen* and broadest at the basal part (that is the portion opposite to the extreme depth of the U) when viewed from above; *notch of supra-anal spine deep and rounded* (U-shaped); wing-covers about 4½ times their greatest width in male, and about 4⅝ times in female...........22. *furcata furcata*, p. 320.

Note.—Typical *S. Curvicauda curvicauda* differs from the race *borealis* in being larger in size, the wing-covers being decidedly longer (33-37 mm.) as well as the hind femora (25-29.5 mm.). It occurs from Maine southward but has not yet been found in Nova Scotia.

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*See Scudder (S. H.), "The Orthopteran Group Scudderiæ," Proc. Amer. Acad. Arts and Sc., vol. 33, Bost., 1898, pp. 271-290 and 1 plate, which fully describes all species then known: and also the more recent revision by Rehn (J. A. G.) and Hebard (M.), "Studies in American Tettigoniidæ: Synopsis of Species of Genus Scudderia," Trans. Am. Ent. Soc., vol. 40, 1914, pp. 271-314, with 3 plates of anal appendages, etc. Students should be very cautious in accepting names used for species of *Scudderia* previous to the appearance of Scudder's paper of 1898, as the nomenclature had formerly been most lamentably mixed up.

Field Key to Nova Scotian Species of Scudderia.

Males.

The following condensed key may be used as a more ready but cruder means of separating our male *Scudderia:*—

a. Notch in end of spine on upper side of extremity of body (supra-anal spine) rather shallow and acute or *V-shaped*, the two branches of the fork not swollen.

b. Greatest width of wing-cover *over 8 mm.* (ends of branches of fork gently tapering)........................20. *pistillata*, p. 312.

bb. Greatest width of wing-cover *under 8 mm.* (ends of branches of fork of about equal width)........21. *curvicauda borealis*, p. 317.

aa. Notch in end of spine on upper side of extremity of body very deep and well rounded or *U-shaped*, each branch of the fork very much swollen. 22. *furcata furcata*, p. 320.

Females.

The following key may serve to distinguish our female *Scudderia:*—

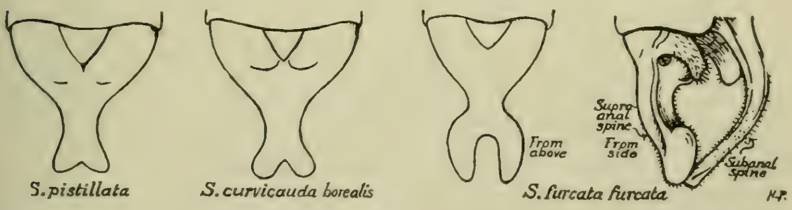
a. Disk of pronotum with sides distinctly widening posteriorly.

b. Wing-covers relatively broader, over 8 mm. in greatest width, their proportions being about 1 to 3; eyes smaller. .20. *pistillata*, p. 312.

b. Wing-covers relatively narrower, under 8 mm. in greatest width, their proportions being about 1 to 4½; eyes larger............... 21. *curvicauda borealis*, p. 317.

aa. Disk of pronotum with sides nearly parallel; wing-covers narrow, their proportions being about 1 to 4⅝ .... 22. *furcata furcata*, p. 320.

The ovipositors of the three forms closely resemble each other, although that of *furcata* is relatively narrower than that of the other two. Identification by ovipositor is very difficult with these insects and must be done with the greatest caution by a beginner.



Distinguishing Forms of Supra-anal Spines of Males of Species of *Scudderia.* (Enlarged about 5 times.)

The first three figures show the spine as viewed from above, the fourth is a lateral view. The figure of *S. pistillata* is from a specimen collected at Halifax, that of *S. curvicauda borealis* is from one collected at Wilmot, N. S., on 6 Sept. 1915, and that of *S. furcata furcata* from one taken at Chocolate Lake, Halifax, on 30 Sept. 1917.

20. **Scudderia pistillata** Brunner. NORTHERN KATYDID.

?*Phaneroptera curvicauda* (not of DeGeer). F. Walker, Cat. Derm. Salt. Brit. Mus., ii, 335 (1869); United States.—Do., Can. Ent., iv, 30 (1872); Nova Scotia.*

Scudderia pistillata. Piers, Trans. N. S. Inst. Sc., ix, 211 (1896); Halifax and Ann. Cos.

(Note.—The synonymy of this and other species of *Scudderia* was very badly confused until Scudder in 1898 finally fixed the standing of the then-known species; and students should be very cautious in accepting specific names of the genus used by writers before that date.)

Description.—Like other representatives of the genus, this species has a very odd appearance with its long antennæ, leaf-like wing-covers and wings, and long and very slender hind-legs.—Disk of pronotum distinctly broadening from the front backward; wing-covers leaf-like, *fairly broad* (the length about 3 times the greatest breadth). Supra-anal spine of male forked, the apical notch *acute* and shallow, without a median tooth, and narrower than the upturned sub-anal spine; the lateral processes (on the sides of notch) sub-triangular and distinctly *tapering toward their ends* when viewed from above, the underside of these processes bearing a small vertical longitudinal flange or keel. Greatest width of ovipositor about ½ of its upper chord. Hind femora about 21 (male) or 20 mm. (female). Disk of pronotum wider posteriorily than anteriorly, the posterior width 1.5 times the anterior. Females may be distinguished from those of *furcata* by the shape of the pronotum disk, and from *curvicauda borealis* by the relatively broader wing-covers.

Colour.—From five males, just taken, Halifax, N. S., 26 Aug., 1895. General colour above, including wing-covers, pale oil-green or apple-green; under parts whitish green. Antennæ brownish, greenish basally; upper part of eyes brown; vertex of head white, middle of face greenish-white, mouth and between legs white. Dorso-lateral angle of pronotum with a cream-buff stripe. Abdomen terre-verte green, malachite-green on sides; posterior margin of abdominal segments brighter green (appearing as annular stripes of brighter green on darker green); two longitudinal, slightly raised, white lines on ventral surface of abdomen. Soles of feet brownish.

Measurements.—The following are comparative measurements of the five males (a-e) taken at Halifax, 26 Aug., 1895, whose colour has just been

*Walker listed two species of Katydid as having been taken in Nova Scotia by Lieut. Redman, to which he applied the names "*Phaneroptera curvicauda* De Geer" and "*Phylloptera myrtifolia* Serv." Until the specimens in the British Museum are carefully examined by some-one perfectly familiar with the North American forms as at present recognized, the best we can possibly say is that these two names as used by Walker to designate Nova Scotian specimens, represent two of the three forms *Scudderia pistillata*, *S. curvicauda borealis*, and *S. furcata furcata*.

described; and a sixth male (f) taken at Chocolate Lake, near Halifax, 10 Sept., 1916:

	a	b	c	d	e	f	Ave.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Body to end of anal appendages...	23.0	23.0	23.7	23.7	25.0	20.0	23.0
Body exclusive of anal appendages........................	20.5	20.7	21.5	21.5	22.0	17.0	20.5
Pronotum, length..............	....	.....	.....	.....	.....	5.2	
Pronotum, anterior width.......	....	.....	.....	.....	.....	2.8	....
Pronotum, posterior width......	....	.....	.....	.....	.....	4.25	....
Wing-covers, length............	30.0	30.5	29.0	30.5	30.0	29.5	29.9
Wing-covers, greatest width.....	9.7	10.2	9.7	10.0	10.2	10.2	10.0
Hing wings, length.............	32.0	32.5	31.7	32.7	31.0	32.0	32.0
Hind wings, greatest width......	14.5	15.2	14.5	14.5	14.5	....	14.6
Hind wings extend beyond wing-covers....................	5.2	4.0	....	5.2	4.0	4.5	4.6
Hind femora....................	20.5	20.5	20.5	22.0	20.5	21.0	20.8
Hind tibiæ.....................	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Antennæ........................	30.5	32.0	31.7	31.0	31.7	29.0	31.0
Eye, verticle diameter..........	....	.....	.....	.....	.....	1.3	....
Width of wing-cover contained in its length; times............	3.09	2.99	2.99	3.05	2.94	2.89	2.99

Measurements given by writers in the United States are: Male: body, 19-22 mm.; pronotum, 5.5 mm.; wing-covers, 30-32 mm.; width of wing-covers, 10 mm.; hind femora, 21-22 mm. Female: body, 19-22 mm.; pronotum 5.5 mm.; wing-covers, 26-27 mm.; width of wing-covers, 8-8.5 mm.; hind femora, 20-21 mm.; ovipositor, 6.5 mm. (Width of wing-cover contained in its length, from 3 to 3¼ times.)

Range.—Northern United States and southern Canada east of the Great Plains (or about long. 110°): from Nova Scotia, Maine, Toronto (Ont.), Mich., Minn., Winnipeg (Man.), and Regina (Sask.), south to northern New Jers., Penn., Ind., Ill., Nebr., So. Dak., and Wyom. It thus ranges from the southern part of the Canadian Zone to the northernmost part of the Upper Austral, north of about lat. 40°. Occurs in greatest numbers in the southern portion of Canadian Zone; and common everywhere in northern New England.

Occurrence in Nova Scotia.—I have not much doubt that this is the species which F. Walker reported as *Phaneroptera curvicauda*, from Nova Scotia in 1872 (Can. Ent., iv, 30), as even Scudder himself did not distinguish between these two species in 1862, and it was not until 1878 that Brunner separated them. In reply to my enquiry whether Walker's Nova Scotian *curvicauda* was *pistillata*, B. M. A. Cummings of the British Museum informs me (14 Jan., 1916): "We have not in the British Museum collection a specimen of *S. pistillata*, and under *S. curvicauda* a general locality-label is given for Nova Scotia, but no particular specimen labelled. There

are three specimens of *S. curvicauda*." That is, Walker's Nova Scotian specimen cannot now be referred to, and probably is lost. Of course the specimen may quite possibly have been what has lately been named *S. curvicauda borealis*, a form which occurs in the western part of the province; but as the specimens which Walker examined were collected most likely about Halifax, doubtless by Lieut. Redman, and I have not yet found that form here, whereas *pistillata* is very common, it seems best to consider Walker's record as referring to the latter species.

I first collected *S. pistillata* at Halifax on 26 Aug., 1895, and the determination was verified by Dr. Scudder himself who revised the genus in 1898 and placed it on its present sound basis. It was reported from Nova Scotia in 1896, that being the first Canadian record for Canada under its proper name. Elsewhere in that region it has only been recorded from Toronto, Winnipeg and Regina in the west. Strange to say B. Long did not happen to meet with it, or indeed any species of *Scudderia*, in Prince Edward Island, where it should occur and may yet be found.

This species is very common about Halifax, and no doubt more or less so throughout all or the greater part of the province, although in the western section *S. curvicauda borealis* is rather common and to some extent replaces it. The latter I have not yet found near Halifax. C. B. Gooderham speaks of *S. pistillata* as rather common about Truro; and he has in his collection several specimens taken at Truro, Col. Co., Hantsport, Hant's Co., Wilmot, Ann. Co., Weymouth, Digby Co., and Deerfield, Yar. Co.; and there are also six specimens in the collection of the Agricultural College, Truro; while I have seen specimens taken at Tatamagouche, Col. Co., at Middleton, Ann. Co. (Irene Cox), at Brooklyn, Yar. Co. (Dorothy Marrell), and at Yarmouth, Yar. Co. (E. C. Allen, who had also collected the Deerfield specimens beforementioned). It therefore clearly occurs, fairly com-

monly, at least from Tatamagouche, on Northumberland Strait, south-westward throughout the Annapolis Valley to Yarmouth. No data is available regarding its occurrence in Cape Breton Island.

It is found upon the foliage of clusters of shrubs and low bushes, chiefly Speckled Alders (*A. incana*), in or near somewhat swampy or damp ground in the vicinity of land which is more or less cleared. Usually there is only one male on each bush. On the juices of these shrubs it feeds with the aid of its sharp mandibles; and its eggs, instead of being deposited in the earth or in twigs or grass-stems, etc., as is usual with most of the Orthoptera, are glued in double rows like flattened hemp-seeds, to the outer surface of slender twigs or are inserted in the edges of leaves. All the members of the *Phaneropterinæ* agree in this manner of oviposition. *S. pistillata* is usually extremely slothful, although the male occasionally flies some distance from bush to bush, but if in doing so he comes to the ground, he generally falls most awkwardly on his side. If detected while on a bush he can usually be easily taken with the fingers, although occasionally when approached he will suddenly drop to a branch beneath. Females are excessively secretive and are very rarely observed, one reason being that the male only proclaims his location by loud calls. Considering the great difficulty of determining the species to which females belong, most students perhaps are quite thankful for this.

The Katydids, because of their green colour, leaf-like form, and very slow movements, are extremely difficult to distinguish from the leaves among which they are. The best way to ascertain their exact location is by taking rough cross-bearings. First listen for their call-note and so get the bearing, and then go around until approximately at a right-angle with the former position, listen again for the call, and thus obtain another bearing which intersects the first one. Then on going cautiously to the spot indicated by these cross-bearings and listening once more for the guiding note,

the eye after some searching will usually be able to detect the leaf-like insect and, slowly approaching, it may be taken by the fingers—if it does not suddenly drop among the leaves below! At night a lantern has to be used to see the insect, what is known as a "dark" one being no doubt best for the purpose.

Although so difficult to detect owing to its similitude to a leaf and its sluggish movements, yet the loud stridulation of the males after nightfall makes known its approximate location. During the day they are usually silent, or rarely produce a short, sharp note, *zip*. After nightfall, however, their ear-piercing notes are as notable a rural chorus in late summer and autumn as those of the Tree Toads in spring. It is by far the loudest sound produced by any of our Orthoptera exclusive of other members of its own genus. The calling organ consists of a transparent membrane at the base of the overlapping dorsal area of one of the wing-covers, the membrane being crossed by a prominent curved vein bearing a row of minute file-like teeth on the under side, which are rasped over a vein on the upper surface of the under wing-cover, in which way a strident note is produced. On watching the male, he will be seen occasionally to suddenly lift, part and then again close the wing-covers, producing a sharp *zip* or *crick*, not very loud, which is the same as the day note. After making this sound at irregular intervals for sometime, he opens and closes the wing-covers to a greater extent, and so produces a long-drawn, exceedingly loud, fierce-sounding *cr-r-r-r-r-ick!* or *tschr-r-r-r-ip!*, which is repeated in couplets several times. This vehement challenge is then answered successively by every other male in his vicinity, until numbers are rasping out their chorus of ear-piercing notes, which are borne far on the still night air. After a while the notes become few, but later are started again by another bold male; and so the tumult is kept up intermittently throughout the night. I

have often stood near the dark alder thickets, in the calm close nights of August and September, listening to them and the wide-spread continuous undertone from thousands of tiny Crickets among the short grass of the adjacent pasture land, and I could not but have some admiration for the bold, fierce nature which the former's passionate challenge seemed to indicate in those lurking green-clad bushmen, though one could never grow to love them like the little Cricket whose softer serenade lulls rather than arouses.

Its notes are first heard near Halifax about 9th August (8 Aug. '97, 28 July '04, 8 Aug. '09, 12 Aug. '10, 1 Aug. '11, 17 Aug. '16, 19 Aug. '17), a week after the first cricket is heard, and are common throughout that month and September. They are last heard about 20th October (17 Oct. '95, 21 Oct. '15), about the time of the first hard frost which usually occurs in this province near 16th October.

Strange to say, while the species is so very common and its notes must be so very audible to all, yet it has received no vernacular name here; and in fact I have not found anyone but a naturalist who has ever seen the insect, and great surprise is expressed at its appearance when a captured specimen is shown.

21. **Scudderia curvicauda borealis** Rehn and Hebard.

Broad-winged Curved-tailed Katydid.

Description.—This geographic race closely resembles *S. pistillata* in general appearance, and the form of the supra-anal spine of the male is also generally similar, except a slight difference in the shape of the branches of the spine.—Supra-anal spine forked, the apical notch acute and shallow, without a median tooth; the lateral processes (on sides of n tch) *subequal in width* (not tapering) and somewhat rounded at end when viewed from above, the underside of these processes bearing a small vertical *longitudinal flange or keel.* Wing-covers proportionately *rather narrow* (the length about 4¼ times the greatest breadth in male and about 4½ in female). Greatest width of ovipositor about one-half of its upper chord. Hind femora about 20.2 to 22.6 mm. Disk of pronotum wider posteriorily than anteriorly, the former being 1.4 of the latter.

From *pistillata* it may be separated by the larger eyes, much narrower wing-covers (6.5 to 7 mm. in male *borealis*, as compared with 9 to 11 mm. in male *pistillata*), somewhat longer hind femora, much smaller tympanal area of the male wing-covers, and the sub-equal width of the branches of the supra-

anal spine (they not being tapering as in *pistillata*). From typical *S. curvicauda* it differs in its smaller size, more compact form, and the broader and shorter wing-covers. From *S. furcata* it is very readily separated by the form of the supra-anal spine. Females are distinguished from those of *furcata* by the shape of the pronotum disk, which widens posteriorly; and from those of *pistillata* by the relatively narrower wing-covers.

Colour.—General colour green, the lateral angles of the pronotum in most cases weakly outlined with brownish white. Two Nova Scotian specimens in the Provincial Museum are green with reddish-brown tibiæ; one has a pale buffy line on edges of disk, along the lateral angles of the pronotum, the other is suffused with pale reddish-brown on most of head, pronotum, and humeral angles of wing-covers.

Measurements.—Male: body, 18.2-22.3 mm.; posterior width of pronotum, 3.3-3.6 mm.; pronotum, 5-5.4 mm.; wing-covers, 27.8-29 mm.; greatest width of wing-covers, 6.5-7 mm.; posterior femora, 21.8-22.7. Female: body, 18-20.4; pronotum, 5.1-5.4 mm.; posterior width of pronotum, 3.6-3.8 mm.; wing-covers, 25.2-29.7 mm.; posterior femora, 20.8-22.6 mm.; ovipositor, 7-7.4 mm. Width of wing-cover contained in its length very slightly more than four times on an average. (*Vide* Rehn and Hebard.)

Two of the Nova Scotian males from Mr. Gooderham's collection have been presented to the Provincial Museum, viz. one taken at Wilmot, Ann. Co., 6 Sept., 1915, by W. E. Whitehead, and the other without data, and these furnish the following measurements:—

	Male, Wilmot 6-9-15	Male
Body, to end of subgenital plate	19.4mm.	20.3mm.
Body, exclusive of anal appendages	16.0	....
Pronotum, length	5.0	4.7
Pronotum, anterior width	2.5	2.5
Pronotum, posterior width	3.4	3.5
Wing-covers, length	27.5	26.5
Wing-covers, greatest width	6.5	6.5
Hind wings, length	30.0	....
Hind wings extend beyond wing-covers	4.0	....
Hind femora	20.2	21.0
Hind tibiæ	22.0	22.5
Subgenital plate, length	6.5	6.2
Eye, vertical diameter	1.5	1.5
Width of wing-cover to length of same	¼th	¼th

Range.—This is the race occurring in the extreme northern portion of the range of *S. curvicauda*. It has a limited distribution which borders that of *curvicauda curvicauda* in the north and northwest. Hitherto it has only been reported from Maine (in bogs), Ontario (Severn River, Tobermory, and Toronto), and Manitoba (Aweme), being found typical only in the Canadian Zone. Dr. E. M. Walker's Toronto specimens show some tendency toward *curvicauda curvicauda*.

Occurrence in Nova Scotia.—This geographical race was first described in 1914 by Rehn and Hebert (Trans Amer. Ent. Soc., 40, p. 281) from specimens taken in Maine, Ontario, and Manitoba. I have not so far detected it about

Halifax although it may very easily have been mistaken for a narrower-winged variety of *S. pistillata*, which at first I took it to be.* The typical *S. curvicauda curvicauda* has not so far been found in our province and is without doubt replaced in this region by the race *borealis*. The record of *Phaneroptera curvicauda* from Nova Scotia by F. Walker in 1872 (Can. Ent., iv, 30), appears to me to have been *S. pistillata*, as mentioned under that species, but one cannot be at all certain as his specimen seems to be lost.

C. B. Gooderham of the Agricultural College, Truro, who first drew my attention to this insect, has in his collection certain specimens of this new subspecies, viz.: two males and two females taken at Wilmot, Ann. Co., 6 Sept., 1915, by W. E. Whitehead; three males taken at Truro, Col. Co., 8 Oct., 1916, by himself, and one specimen from Deerfield, Yar. Co., by E. C. Allen. In the collection of the Agricultural College, Truro, is one male taken at Kentville, Kings Co., on 12 Aug., 1914, by C. A. Good. It doubtless occurs from early in August until about the middle of October. Specimens sent to J. A. G. Rehn by Mr. Gooderham in Feb. 1917 were verified by the former as his and Mr. Hebard's *S. curvicauda borealis*, so that the determination is authoritative.

While I have not, as before said, detected it about Halifax, it very likely may occur here and should be searched for. In the western part of the province from Truro to Yarmouth, Mr. Gooderham tells me it appears to be rather common, as he has taken it at two or three different places and has received it from two others, and he thinks that in that region it must be as abundant as *S. pistillata*. E. Chesley Allen informs him that there is a narrow-winged *Scudderia* which is very common about Deerfield, Yar. Co., which is probably *borealis*, as Mr. Gooderham has one specimen of

*Prof. W. S. Blatchley in 1916 referred some of Mr. Gooderham's specimens to *S. pistillata*, and Dr. E. M. Walker referred them at first to *S. curvicauda* but he now agrees that they are the form *borealis*.

the latter from that place collected by Mr. Allen. One would expect to find it occurring on bushes in bogs, as is the case in Maine.

22. **Scudderia furcata furcata** Brunner. NORTHERN FORK-TAILED KATYDID.

?? *Phylloptera myrtifolia* (not of Serville) F. Walker, Cat. Derm. Salt. Brit. Mus., ii, 376 (1869); Canada. —Do., Can. Ent., iv, 30 (1872); Canada, Nova Scotia.

Description.—While generally resembling our other species of *Scudderia*, this one may be very readily separated from them by the form of the supra-anal spine of the male. Females may probably be best distinguished by the nearly parallel sides of the disk of pronotum.—Wing-covers proportionately somewhat narrow (the length about 4½ times the greatest breadth in the male, and about 4⅝ in the female). Supra-anal spine of male deeply forked, the apical *notch deep and rounded* (distinctly U-shaped), without a median tooth; the lateral processes (on sides of notch) not much longer than broad, *decidedly swollen* and broadest at the basal part (that is, about opposite the extreme depth of the U) when viewed from above, and these processes *not longitudinally flanged or keeled* along their lower surface. *Disk of pronotum with nearly parallel sides* (in male and female of *pistillata* and *curvicauda borealis* it distinctly broadens backward). Greatest width of ovipositor about $^{2}/_{5}$ths of its upper chord. Hind femora about 17.2 to 22 mm.

Colour.—General colour dark leaf-green, occasionally more or less suffused with brown; the head and pronotum paler; the lateral angles of the pronotum usually not outlied with yellowish.

Measurements.—Male: body, 14-18 mm.; pronotum, 5 mm.; wing-covers, 26-31 mm.; greatest width of wing-covers, 6-6.5 mm.; hind femora, 19-22 mm. Female: body, 18-22 mm.; pronotum, 5 mm.; wing-covers, 26-30 mm.; width of wing-covers, 6 mm.; hind femora, 20-22 mm.; ovipositor, 5 mm. Width of wing-cover contained in its length about 4½ times in male and about 4⅝ in female. (*Vide* Rehn and Hebard.)

The following are comparative measurements of two males of *S. furcata furcata* taken at Chocolate Lake, North West Arm, near Halifax, N. S., 30 Sept., 1897:

	A.	B.
	mm.	mm.
Body to end of anal process	17.5	18.5
Body exclusive of anal process	15.2	16.0
Pronotum, length	4.7	4.1
Pronotum, anterior width	2.7	3.0
Pronotum, posterior width	3.0	3.2
Wing-covers, length	28.0	27.2
Wing-covers, greatest width	6.0	6.0
Hing-wings extend beyond wing-covers	4.0	3.5
Hind femora	18.0	17.2
Hind tibiæ	19.0	18.2
Antennæ	....	34.0
Eye, vertical diameter	1.5	1.5
Width of wing-cover contained in it length; times	4.66	4.52

Range.—This form ranges over the United States and southeastern Canada east of the Great Plains: from Nova Scotia, Brunswick (Maine), Montreal (Que.), Lake Nipissing (Ont.), and Wisc., south to Fla., around the Gulf Coast to Texas, Nebr. and So. Dak. Specimens showing atypical tendencies are found in Idaho, Wash., Oregon, and Calif. Southwestward it intergrades with *S. furcata furcifera* Scudder, which occurs typically in Mexico and New Mexico It is common everywhere in New England.

Occurrence in Nova Scotia.—It is very far from certain that this was the species referred to by F. Walker (1872), under the name *Phylloptera myrtifolia*, as having been taken in Nova Scotia. B. M. A. Cummings of the British Museum in reply to my query whether Walker's Nova Scotian specimen of "*P. myrtifolia*" is *S. furcata*, writes me (14 Jan. '16) that there is in that Museum "one specimen with label 'Redman' [that is, Lieut. Redman, the collector who supplied Walker's Nova Scotian specimens]; also one *S. furcata* with which the former does not agree. In the collection the Nova Scotian specimen is labelled *P. myrtifolia* as synonymous with *S. laticauda*. In W. F. Kirby's Systematic Catalogue of Orthoptera (ii, 445-446, 1906) it is given as synonymous with *S. furcata*." Mr. Cummings adds, "I do not think the Nova Scotian specimen will prove to be either *S. furcata* or *S. laticauda*." *S. laticauda*, of course, it cannot be. All we can say is, that Walker's *Phaneroptera curvicauda* and *Phylloptera myrtifolia* from Nova Scotia, must represent two of the three forms *Scudderia pistillata*, *furcata furcata*, and *curvicauda borealis*, but which of them it is difficult at this distance to say. His *curvicauda* I think muet have been *pistillata*.

Scudderia furcata furcata had not been detected by me when I published my paper on Nova Scotian Orthoptera in 1896. In the dusk of the evening, on 30 September, 1897, I captured two males of this form at Chocolate Lake, near the head of the North West Arm, near Halifax, N. S.* One of these was on a balsam fir (*Abies balsamea*), the other on a witherod bush (*Viburnum cassinoides*), and a third, which

* The spot where these specimens were taken was a few rods from the shore on the south side of Chocolate Lake near its east end. The ground was dry there, but adjoining it southward was a small bog. At the spot were low bushes, small balsam firs and large white pines with a few red spruces. The pine was the characteristic tree of the locality.

I did not succeed in capturing, was seen on a fir tree. In the vicinity were large white pines and spruces. At the time I heard about a dozen others, presumably of the same species. Their note was chiefly a very short *zip*, but unlike that of *S. pistillata*. These two specimens agree fully with Scudder's description and plates in his paper on The Orthopteran Group Scudderiæ (Proc. Am. Acad. Arts and Sc., Bost., p. 33, 1898), the form of the supra-anal spine leaving no doubt whatever as to the determination.* Their measurements have been given on page 320. I did not determine the specimens until the spring of 1916, and in going to the same locality in the following summer, I only happened to find *S. pistillata*, but further search will without doubt show it is still there.

This form is no doubt rare or quite uncommon about Halifax, and C. B. Gooderham informs me that he has never seen it near Truro, Col. Co., or in the western counties of Nova Scotia, and there is no specimen in the collection of the Agricultural College, Truro. Still we would expect it to be more related to the fauna of our Transition region than to that of the Canadian region of eastern Nova Scotia. In New England it is everywhere common. It probably appears later than *S. pistillata*, and should be met with from August to October. In New Jersey it occurs usually in pine barrens, and in Indiana is mostly seen on low bushes and trees about the margins of thickets and along fence-rows, while in the prairie country to the north it frequents coarse grass and weeds in company with *S. pistillata*.

The characteristic keelless, deeply and widely forked and much swollen end of the supra-anal spine of the male will very readily distinguish it, on careful examination with a lens, from *S. pistillata* and *S. curvicauda borealis*. Females may be separated from those of *S. pistillata* by the proportionately narrower wing-covers of *furcata;* and the proportionately narrower ovipositor of the latter may help in

* See figure of supra-anal spine of one of the Chocolate Lake specimens, on page 311.

distinguishing them from *curvicauda borealis*. Comparison of the shape of the disk of the pronotum, whether it expands somewhat behind, or is nearly parallel, will also assist; but positive determination should be made on examination of the male alone.*

Subfamily **Conocephalinæ** (Cone-headed Grasshoppers and Meadow Grasshoppers).

Vertex of head terminating in a tubercle or spine, sometimes blunt; antennæ long; pronsternum toothed or with two slender spines (these very short and weak in our species of *Conocephalus*); wing-covers narrow; ovipositor usually long and straight, but sometimes upcurved (in *Orchelimum*). To this subfamily belong certain slender-bodied green grasshoppers, with long antennæ and sword-shaped ovipositors, which are common in damp meadows and along the margins of brooks, etc. Their song is produced in the same manner as that of the Katydids, by a stridulating organ at the base of the wing-covers; but the notes are quite soft and low and are heard throughout the day. The eggs are deposited between the stems and root-leaves of grass, in the pith of twigs, etc.; and the ovipositor, being used as a piercer, is slender and sharp-pointed. Only one genus, *Conocephalus* (=*Xiphidium*), has so far been reported from Nova Scotia, but *Orchelimum* may possibly yet be found although it is not at all likely to be. These genera may be separated thus:—

KEY TO GENERA OF CONOCEPHALINÆ.

Fore and middle femora without spines beneath, vertex terminating in a rounded tubercle hollowed on sides, stridulating organ light brown;

a. Prosternal spines very short; ovipositor slender and straight or nearly so; insect small, body less than 17 mm . . . . CONOCEPHALUS, p. 324.

aa. Prosternal spines longer and more slender; ovipositor stout and usually upcurved; insect of medium size, body more than 17 mm. (Not yet reported from Nova Scotia.) . . . . [ORCHELIMUM, footnote p. 325.]

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*Scudderia septentrionalis (Serville), readily distinguished by the truncated apex of the male supra-anal plate, although it occurs north to Brunswick, Maine, is very rare and not at all likely to occur here; and *S. texensis* Sauss.-Pict., with a median tooth in the notch of the supra-anal spine, although it has been taken at Norway, Maine, and in southwestern Ontario, is just as unlikely to be found this far north.

Group Xiphidiini.

23. **Conocephalus fasciatus fasciatus** (DeGeer). Eastern Slender Meadow Grasshopper.

Xiphidium fasciatum. F. Walker, Cat. Derm. Salt. Brit. Mus., ii, 270 (1869); Nova Scotia, etc.—Do., Can. Ent., iv, 30 (1872); Nova Scotia.—Piers, Trans. N. S. Inst. Sc., ix, 213 (1896); Halifax and Windsor, N. S.

Description.—Very slender-bodied and delicately formed. Vertex of head extends forward and slightly upward as a rounded tubercle; antennæ long; face oblique; prosternal spines very short and weak; wing-covers narrow, straight and *extending much beyond abdomen;* wings a little longer than wing-covers; ovipositor slender, *straight,* and about two-thirds length of hind femur; hind legs long and slender; femur and tibia about equal in length.

Colour.—Nova Scotian specimen, just come to maturity. General colour a beautiful translucent, light apple-green, very finely sprinkled with liver-brown, mostly on face and sides of head, pronotum, and legs; the spots on the hind femora being mostly arranged in a few longitudinal lines. Antennæ drab; eyes clove-brown. A dark brown dorsal stripe from vertex to extremity of abdomen, this stripe narrow on head and expanding into a rather broad band on pronotum and abdomen. Sides of abdomen dark brown. Wing-covers from greenish white to yellowish white, with brownish red dash on lateral basal part, this colour extending onto the veins. Hind femora apple-green, their apical third fawn-colour; hind tibiæ light fawn-colour, the spines tipped with black. Ovipositor green, its dorsal surface and tip fawn-coloured.

Measurements.—Male: body, 12-13.5 mm.; pronotum, 3-3.5 mm. wing-covers, 14-18 mm.; hind femora, 11.5 mm. Female: body, 12-14.5 mm.; pronotum, 3 mm.; wing-covers, 15-19 mm.; hind femora, 11.5-13 mm.; ovipositor, 7-9 mm.

Range.—United States and southeastern Canada, from Rocky Mtns. to Atlantic and south to South America: from Nova Scotia, P. E. Island, New Brunswick, Montreal (Que.), Ont., and Man., south to Fla. and Mexico, and west to Col. and Mont. The range of this geographic race is therefore extensive, its present known northern limit being apparently in the Canadian Zone. It is generally a very common form.

Occurrence in Nova Scotia.—This pretty, very fragile little insect, the smallest of our *Tettigoniidæ,* was first reported from Nova Scotia by F. Walker in 1869. It is very common throughout the province, at least in those parts which have come under the eye of the collector, as about Halifax, Truro, Windsor, Kentville, Church Street (Kings Co.), near Yarmouth and Deerfield (Yar. Co.), etc. It frequents damp situations, such as wet meadows and marshes, and is found among moist thick patches of succulent and rank-growing

grass. It is very active and makes extensive leaps. The very tiny but easily recognizable nymphs, in about the second stage, were not noted at Hubbards, Hx. Co., until 19 July, 1917. Adults are met with from about the middle of July (18 July, '97; 29 July, '16, Halifax) until the middle of September (10 Sept., '95, and 12 Sept., '97, Halifax; and 13 Sept., Truro). They no doubt succumb to the first hoar-frosts which occur about then or soon after, being probably the first species to do so. Females are seen much more frequently than males. The stridulation of the male is rather weak-sounding, as might be expected from such a frail little species, and to me sounds like the syllables, *plee-e-e-e-e-e, tzit, tzit, tzit, tzit*, the first part of the call being a rapid vibratory note.*

Subfamily **Stenopelmatinæ** (Stone and Camel Crickets).

Pronotum short, not covering whole top of thorax; prosternal spine absent; *wings wholly absent;* hind femora stout; ovipositor nearly straight.—These are ungainly insects, stout, with long antennæ, an arched back, and a large head which is bent downward in an obsequious manner between the front legs. They are nocturnal in habit, concealing themselves by day beneath stones, logs, etc., in damp woods or along woodland brooks, and are therefore rarely observed except by the collector. Being wingless they make no sound by which they may be located. They are omnivorous feeders but do not injure cultivated crops. The eggs are supposed to be laid in the earth; and in the United States the young occasionally hibernate, but no doubt do not do so here. The females are very difficult to specifically

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***Orchelimum vulgare* Harris, the Common Meadow Grasshopper, length 18-19 mm., with spines on prosternum cylindrical and slender, has been taken in southern Maine and elsewhere throughout New England, where it is common, as well as in southern Quebec and Ont., but it is not likely to be found as far north as Nova Scotia; as also *Conocephalus brevipennis* (Scudder), the Short-winged Meadow Grasshopper, length 11-13 mm., somewhat like *fasciatus* in general form, but with wings usually shorter than the wing-covers, and the latter usually not reaching the end of the abdomen, which is common everywhere in New England and north to Eastport, Me., Ont., and Montreal (Quebec).

identify. Only one genus, *Ceuthophilus*, is represented in Nova Scotia.*

Group Ceuthophili.

KEY TO NOVA SCOTIAN SPECIES OF CEUTHOPHILUS (MALES).

a. Hind margin of terminal dorsal segment of abdomen distinctly obtusely *notched;* hind tibiæ arcuate or bowed in their basal third............... 24. *maculatus*, p. 326.

aa. Hind margin of terminal dorsal segment of abdomen *entire*, rounded; hind tibiæ straight; lower outer carina of hind femora with 25 to 30 minute teeth, crowded together over two-thirds or more of apical part; hind femora distinctly shorter (about one-tenth less) than hind tibiæ, and 3½ times as long as broad; fore femora at least a third longer than pronotum..............................25. *terrestris*, p. 327.

24. **Ceuthophilus maculatus** (Harris). SPOTTED CAMEL CRICKET.

Ceuthophilus maculatus. F. Walker, Cat. Derm. Salt. Brit. Mus., i, 201 (1869); Nova Scotia.—Do., Can. Ent., iv, 30 (1872); Nova Scotia. (Generic name given as "*Onthophilus*" by typographical error).

Description.—(Male). Body stout, back arched, antennæ long. Hind margin of terminal dorsal segment of abdomen obtusely but distinctly *emarginate or notched;* fore femora frequently more than a third longer than pronotum; hind femora about four times as long as broad and about as long as hind tibiæ, the outer lower carina with 12 to 15 small spines; hind tibiæ (of male) arcuate or bowed in basal third. (The emarginate hind margin of the last dorsal abdominal segment of the male clearly separates it from our other species.)

Colour.—Above blackish-brown, often with lighter stripe on dorsal part of thorax; below yellowish-brown; a number of small yellow dots, sometimes somewhat confluent, on dorsal part of abdomen; legs pale reddish-brown, the hind femora with brown bars.

Measurements.—Male: body, 14 mm.; pronotum, 4.6 mm.; fore femora, 6-6.5 mm.; hind femora, 15 mm.; hind tibiæ, 16-17 mm. Female: body, 16 mm.; pronotum, 5 mm.; fore femora, 6 mm.; hind femora, 15 mm.; hind tibiæ, 15.5 mm.; ovipositor, 9.5-10 mm.

Range.—Northern United States and southeastern Canada, east of the Great Plains: from Nova Scotia, Grand Manan (N. B.), Anticosti Isld., Montreal, Niagara Glen (Ont.), and Minn., south to Maryland, and west to Colo. and Nebr. Its range thus extends from the southernmost portion of the Canadian to the northern half of the Upper Austral Zone. Common throughout New England.

Occurrence in Nova Scotia.—This ungainly insect, with its cringing attitude, has hitherto only been reported from

*Students should certainly consult Dr. E. M. Walker's excellent paper and plates on his puzzling genus in the Can. Entomologist (vol. 37, pp. 114-119, 1905; "Notes on the Locustidæ of Ontario"). The above key is founded on points of difference pointed out by him

Nova Scotia by F. Walker in 1869 from a specimen collected many years before by Lieut. Redman. This Nova Scotian specimen is still in the British Museum collection, and B. M. A. Cummings, who has re-examined it for me, states that it is correctly determined.

I have not so far met with the species about Halifax, although possibly it will yet be obtained in suitable places in that locality. Being silent and secretive, it is a difficult insect to find and careful search has to be made for it. C. B. Gooderham has five specimens taken in Colchester and Annapolis Counties from 6 to 25 August, which have been determined by Dr. E. M. Walker of Toronto and verified by Prof. W. S. Blatchley of Indianapolis. They consist of three males taken at Truro, Col. Co., one on an unknown date by Miss L. C. Eaton, and the other two on 10 Aug. 1913; one female from the same place, 6 Aug. 1913; and a second female collected at Granville Ferry, Ann. Co., by H. G. Payne, without date. There are also in the collection of the Agricultural College, Truro, two males from Black Rock, Col. Co., 25 Aug., 1913. Of these seven specimens, the five with dates attached were collected by Mr. Gooderham. This gentleman considers it to be very rare about Truro, and apparently it is also rare in other sections of the western portion of the province, although possibly somewhat less so than its number in collections would indicate. It is usually found under flat stones in dry open woods, as well as beneath logs and in hollow trees. Like other species of its subfamily, it is wholly silent, as being wingless it has no stridulating organs. Adults probably should occur from about the middle of July, but we have no data to confirm this.

25. **Ceuthophilus terrestris** Scudder.

Description.—(Male). Body stout, back arched, antennæ long. Hind margin of terminal dorsal abdominal segment *not notched*, but obtusely rounded; fore femora at least a *third longer than pronotum*, hind femora 3½ *times as long as broad* and distinctly shorter (about one-tenth less) than hind tibiæ, the outer lower carina with about 25 crowded minute teeth; hind tibiæ straight in male as well as in female.

Colour.—Reddish-brown, the abdomen mottled with pale spots; often a light stripe on median dorsal area of pronotum, bordered by darker blotches; legs lighter, the hind femora with obscure dark bars.

Measurements.—Male: body, 13-14 mm.; pronotum, 4.5-5 mm.; fore femora, 6.3 mm.; hind femora, 14.3 mm.; hind tibiæ, 15.5 mm. Female: body, 14-15 mm.; pronotum, 4.3 mm.; fore femora, 6 mm.; hind femora, 13-14 mm.; hind tibiæ, 14 mm.; ovipositor, 7.5 mm. Newfoundland specimens are reported to be very large for the species.

Range.—Northern United States and Canada in eastern parts: north to Newfoundland (Bay of Islands, etc., Hebard), Nova Scotia, Maine, New Hamp., Mass.(?), Anticosti Isld., Isle d'Orleans (Que.), Ont. (north to Muskoka), Keweenaw Bay (Lake Michigan), and Man. Blatchley has reported it from Ind., and Walden very doubtfully from Conn. It seems to be confined to the eastern part of the Canadian and Transition Zones. Scudder says it is not uncommon in northern New England.

Occurrence in Nova Scoita.—This northern species has not previously been reported from Nova Scotia. C. B. Gooderham informs me that he has three specimens of *C. terrestris*, all taken at Truro, Col. Co., which were determined by Dr. E. M. Walker of Toronto, who has specially studied this genus. Prof. Blatchley of Indianapolis, has also verified the determination, so there is no doubt as to the specific identity. Of Mr. Gooderham's specimens, a male and a female were taken at Truro, Col. Co., on 6 Aug., 1913, and a male at the same place on 18 July, 1915. There are no specimens in the Agricultural College collection, and I have not noted it about Halifax. Gooderham refers to it as very rare about Truro. It probably occurs in the adult form from early in July, and should be searched for under flat stones in the open woods, where it may possibly be found in company with the related *C. maculatus*. Like the latter it is a wingless and therefore a silent species, and being secretive it requires considerable searching in likely spots in order to find it.*

*Another species, *Ceuthophilus brevipes* Scudder, is generally a rare one, and has only been taken at Grand Manan Island where it is not uncommon, at St. John, N. B., and in Indiana. We would not expect to find such a rare species in Nova Scotia. Its length is 15 mm.; hind femora shorter than hind tibiæ, the lower carinæ with 7-15 small saw-like teeth; hind tibiæ straight; fore femora about one-third or more longer than pronotum.

Family GRYLLIDÆ (Crickets).

Antennæ much longer than body, bristle-shaped; *wing-covers flat above* and abruptly turned downward at sides; hind femora stout; *tarsi (feet) three-jointed;* ovipositor usually protruding, straight or upturned, needle-shaped, the tip often enlarged; calling organ of male, when present as in our species, is near base of wing-covers as in the *Tettigoniidæ*, but is larger and extends across proximal portion of both anal and median areas of wing-covers. The hind-wings are usually short and of little use for flight, although sometimes extending much beyond the ends of wing-covers.

The familiar chirp of the male cricket is not vocal as many suppose, but is produced by rubbing the veins of the stridulatory area at the base of one wing-cover over those of the other, somewhat as in the *Tettigoniidæ*. The eggs of most species are deposited singly in the ground, and a few of the burrowing species lay theirs in masses in their burrows, while the arboreal tree-crickets (*Œcanthinæ*), which have not yet been found in this province, place theirs in a row in the pith of plants. Oviposition takes place in late summer or early autumn, and the eggs in Nova Scotia doubtless do not hatch till the next season. Many of the species do very considerable damage to pasture-land.

Only the subfamily *Gryllinæ* is so far known to be represented in Nova Scotia. *Gryllotalpa borealis* Burmeister, the Northern Mole-cricket, of the subfamily *Gryllotalpinæ*, with fore tibiæ enlarged and fitted for digging, occurs in the northern half of New England, Anticosti Island, and Ontario, and might possibly be found here, but it is not very likely to be.

Subfamily **Gryllinæ** (Ground and Field Crickets).

Tarsi compressed, second joint minute; fore tibiæ not enlarged; hind tibiæ rather stout, with two rows of stout spines without teeth between them.

KEY TO NOVA SCOTIAN GENERA OF GRYLLINÆ.

a. Species small (length of body less than 12 mm.); last joint of maxillary palpi double the length of preceding one; hind tibiæ with long, movable, pilose spines; first joint of hind tarsi without teeth above, or with one row of small teeth.............................NEMOBIUS, p. 330.

aa. Species large (length of body more than 12 mm.); last joint of maxillary palpi but little, if any, longer than preceding one; hind tibiæ with strong immoveable spines; first joint of hind tarsi grooved above, with two rows of teeth.......................................GRYLLUS, p. 337.

Genus Nemobius (Ground Crickets).

KEY TO NOVA SCOTIAN SPECIES OF NEMOBIUS.

a. Ovipositor distinctly *longer than hind femora,* very nearly straight; colour blackish or fuscous, with dark lengthwise stripes on occiput. 26. *fasciatus* , p. 330.

aa. Ovipositor distinctly *shorter than hind femora,* usually more or less curved; wing-covers reaching tip of abdomen in male, shorter in female, their ground-colour yellowish-brown; dorsal area of pronotum and the legs yellowish-brown more or less mottled with black...27. *carolinus*, p. 335.

26. **Nemobius fasciatus** (De Geer). STRIPED GROUND CRICKET. (Short-winged form, sometimes called *N. fasciatus vittatus* (Harris)).

Nemobius vittatus. F. Walker, Cat. Derm. Salt. Brit. Mus., i, 57, 114 (1869); Nova Scotia, etc.—Do., Can. Ent., iv, 30 (1872); Nova Scotia.

Acheta vittata. Piers, Trans. N. S. Inst. Sc., viii, 410 (1894); Windsor, N. S.

Nemobius fasciatus vittatus. Piers, Trans. N. S. Inst. Sc., ix, 210 (1896); Halifax and Windsor, N. S.

Description.—Size small; head and pronotum hairy; *ovipositor straight or very nearly so and about one-eighth or more longer than hind femora;* wing-covers of male cover about two-thirds of abdomen, while those of female cover about half of abdomen and have prominent cross-veinlets; hind wings wanting in both sexes in short-winged form which has sometimes been called *vittatus* (but are more than twice length of wing-covers and extend, like two tails, to about apex of ovipositor in typical long-winged form *fasciatus*, which latter has not yet been taken here).

Colour.—Nova Scotian specimens. The general colour of the short-winged form, varies from black to brown-black, the wing-covers and legs somewhat paler, particularly the basal part of inside of hind femora; top of head, between eyes, with three black longitudinal stripes, which are very obscure, or not noticeable, in darker specimens. Walden (Connecticut) and Beutenmüller (New York) say there are four black stripes on the head; but such Nova Scotian specimens as are before me, have only three stripes, when noticeable. Ovipositor blackish.

Measurements.—Nova Scotian specimens. Male: body, 10 mm.; pronotum, 1.9 mm.; wing-covers, 4.5 mm.; hind femora, 5.5-6 mm.; hind tibiæ, 4-5 mm. Female: body, 10-12 mm.; pronotum, length 1.9 mm., width 2.6 mm.; wing-covers, 3.5-4.5 mm.; hind femora, 6.0-6.2 mm.; hind tibiæ, 4.6-5 mm.; ovipositor, 7.4-8 mm. (1.07-1.29 times length of hind femora). Blatchley (Indiana) and Walden (Conn.) give the length of pronotum as 3 mm. in both sexes, whereas the Nova Scotian specimens before me are 1.9 or about 2 mm. in that measurement, which agrees closely with Walker's (Ontario) 1.5 mm. for male and 2 mm. for female. (In the extralimital long-winged form the inner wings are about 13 mm. long).

Range.—United States and Canada east of the Great Plains; from Nova Scotia, Quebec, Montreal, Ont. and Minn., south to Maryland, Ind., and Kans. The range therefore extends from the southern part of the Canadian to the northern part of the Upper Austral zone in the east. The long-winged form seems to be generally more or less rare. Very strange to say, this species was not reported from Prince Edward Island by B. Long (*vide* E. M. Walker) in 1912, and it must be truly remarkable if this very common insect does not extend its range there, and one could hardly expect it to be overlooked by any collector. It has not been taken in Newfoundland.

Occurrence in Nova Scotia.—The very common and familiar short-winged Striped Ground Cricket was first reported from Nova Scotia by F. Walker in 1869, as *N. vittatus*, no doubt from specimens collected by Lieut. Redman about 1821.

It is a social species which is excessively abundant in pastures and damp grassy places, as well as along grass-grown roadsides in Nova Scotia; it being one of, if not the most numerous of all the species of Orthoptera of this region. I have seen specimens from Tatamagouche, Col. Co., and have noted it at Westville, Pict. Co. (10 Sept., 1901), and in the counties from thence southward and southwestward, and suppose it must also occur commonly in Cape Breton Island. Neither C. B. Gooderham nor I have ever seen the typical long-winged form (*N. fasciatus fasciatus* as it has been occasionally termed) in this province, although I have often looked for it in the field and in such collections as have come before me. It, however, occurs northward to Maine, and I think also to Ontario.

A few newly-hatched nymphs of a cricket, species undetermined, but which were either *N. fasciatus vittatus* or *Gryllus pennsylvanicus neglectus*, were observed by Mr. Gooderham at Truro on 5 June, 1915. They were very

active, moving and leaping rapidly, and until closely examined might have been easily mistaken for a flea-like insect. Probably both these species hatch at about the same period. Individuals of the Striped Ground Cricket have been first noted by me at Halifax about the middle of July (17 July, '97, six seen, probably nymphs in the later stages). They were then silent and were no doubt immature. I have also observed nymphs of this species, in damp grass, at Halifax, at least as late as 26 August, 1917, when adults were very common.

In this locality they do not begin to shrill or stridulate until towards the end of the haymaking season, the average date for their first notes being about 3rd August, and the earliest date 24 July*; the particular dates being 19 Aug. (1890), 6 Aug. ('91), 29 July ('92, at Windsor, Hants Co.), 2 Aug. ('93), 29 July ('95), 11 Aug. ('96), 2 Aug. ('97), 26 July (1904), 29 July ('08), 5 Aug. ('10), 24 July ('11), 6 Aug. ('16), and 7 Aug. ('17). At first a few are heard and only at night, and so very faintly as to be all but inaudible except to a trained ear. In a few days they may be heard in daytime as well as at night, and the notes become more noticeable; and the shrilling or chirping is fairly common in about a week's time (10 Aug., 1910; 1 Aug. '11; 18 Aug. '16).

All through the latter part of August and September, after the songs of birds have ceased, and when the asters and golden-rods are in bloom, their pulsating multitude of notes is heard from everywhere about the fields. By October they very seldom shrill at night; but on sunny, warm, calm days, with a temperature of over 50° F., their notes are temporarily rather common, but not so incessant or loud as in September, while on some cloudy, cold days they cannot be heard at all. As October proceeds, and the cold increases and frosts occur, the number heard by day becomes fewer and fewer, even when the weather is fine and bright, and the notes are more subdued, and they cease completely at

*The date "17 July" given for first appearance of adults in table on page 232, should be *24 July*. The silent specimens seen on 17 July, 1897, were doubtless immature.

night. By the end of October or the first of November, even on fine days, only four or five individuals may be heard, rather faintly, and the sound abbreviated to a short chirp, not the prolonged trill of early autumn, and now only in daytime. They are last heard at Halifax from about the 7th to the 12th November, according to the character of the particular season and the temperature, the final one being heard about noon on a bright, warm, Indian-summer day when practically all the leaves are off the trees, and after the insect has survived two or three fairly hard night frosts which have formed thin ice and frozen the bare ground. In 1916, as will be more fully described below, a few sleighs were in use only two days after I heard the last cricket.

To illustrate somewhat the effect of weather conditions upon crickets, we may take the autumn of 1916, which was generally a very mild and fine one. On the 11th Oct. the first light frost occurred about some parts of Halifax, and thin ice formed during the mornings of 12th and 18th Oct. and 6th and 12th Nov. About 15th Oct. hardly any crickets were heard; but on the 22nd, a mild, damp day, the prolonged shrilling of many was heard in the daytime, while on the 31st, which was very mild but cloudy, only a couple were faintly heard. On 3rd Nov., a lovely sunny morning after a hoar-frost of the previous night, about a dozen were heard chirring faintly and briefly. On the 6th, another fine sunny day after a night when thin ice had formed and the ground had been slightly frozen, about six were noted, their trill being short and faint. Again on the 12th, after a night of ice and frozen ground, four were faintly heard, in the middle of the day when the temperature was 35° Far., fine and sunny but cold, in short grass on the sunny side of a slope in a pasture at the head of the North West Arm. They were the last noted. Very light snow was on the ground next morning, on the 14th about four inches of snow fell and a few sleighs were out, on the 15th the day temperature was

21°, and on the night of 16-17th the thermometer went down to 11° Far. Again in 1917, on 14th Oct., a sunny warm day with a temperature of 56° Far., many crickets were heard, but faintly. After various hard frosts, only a few were noted on 29th Oct., although the sun was bright and the thermometer at 47°. On the morning of 10th Nov. about an inch and a half of snow was on the ground, but rapidly disappeared. At noon on 11th Nov. I heard four crickets very faintly shrilling, in different warm spots, during a three-mile walk in the vicinity of Dutch Village, Halifax, and they proved to be the last of the season. The day was a bright sunny one, with a noontime temperature of only 31°, and the ground muddy. On the 13th the thermometer was 24° at 9 a. m., but sunny; and on the 15th the North West Arm was extensively frozen about its head for the first time in the season. This seems to show that the first hard frosts silence some of them, but that a few survive as many as four ice-forming frosts and frozen ground, and even evanescent snowfalls, and that a still lower temperature or a fairly heavy fall of snow which lasts for some time, finally causes the last most favourably situated survivors to perish.

The stridulation or shrilling note of the male is produced by the insect lifting the wing-covers about 45° above the body, and then shuffling them very rapidly together so as to vibrate the resonant organ at their base; thus producing a trilling sound or tremolo, of a prolonged character, resembling the syllable *ple-e-e-e, ple-e-e-e, ple-e-e-e,* repeated at rather short intervals or sometimes continued for several seconds or even much longer. The sound has a peculiar silvery timbre, and when myriads are shrilling all over the fields at night, or on fine days in late autumn, when other sounds are hushed and the air filled with the mystic charm of the hour or season, it produces a peculiarly drowsy, ceaseless tremor, pulsation, or "shimmer" of sound which is very familiar and loved by all dwellers in the country.* It

*The continuous shrilling of this cricket reminds one somewhat of the much louder ernal trill of the American Toad when the latter is heard at a distance.

is, however, ineffably associated with a sad feeling that summer is on the wane or past, for it is our most characteristic autumnal sound in grassy places, and is linked with the sight of golden-rods and purple asters and the odour of falling leaves. If one may compare audible things with those seen, there always has seemed to me something about the tremulous shrilling of the little cricket which reminds me of the shimmering effect produced over rising ground on a still summer's morning when the hot sun causes invisible vapour to ascend and so sets the distant landscape pulsating and dancing as if by Terpsichorean bewitchment.

Mingled with the call of this species, particularly about the more stony edges of fields and the sloping sides of country roads, may be heard the louder and more staccato trill of the larger and less social *Gryllus pennsylvanicus neglectus*, but in fewer numbers. When the crickets begin to shrill, and when the chorus is faintly ending in late fall, I sometimes find it difficult to differentiate the notes of these two species, although it is easy to do so in the intervening period of full song. Crickets are one of the few orthopteran families which are known by sight and sound to almost everyone, although they are merely called "crickets" without attempting to specially distinguish the species.

The Striped Ground Cricket is an omnivorous feeder, subsisting upon grasses, carrion and cow-dung, and because of its excessive numbers it must do very considerable damage to pasture land, and is to be considered as a bad enemy of the agriculturist and grazier.

27. **Nemobius carolinus** Scudder. CAROLINIAN GROUND CRICKET.

Description.—In general appearance it bears considerable resemblance to *N. fasciatus* but is smaller and differs in certain other particulars. Wing-covers of male reach about tip of abdomen, those of female cover half abdomen; hind wings wanting; *ovipositor distinctly shorter than hind femora* and a little up-curved. Its small size and short ovipositor readily distinguish it from *N. fasciatus*.

Colour.—Nova Scotian specimen (male, Truro, Col. Co., 12 Aug. 1915). Head dark brown with yellowish markings on vertex; front slightly darker than vertex or cheeks; eyes dark, lighter on upper edge; antennæ dark brown on three basal joints and distal third, middle portion light brown. Pronotum disk mottled with spots of light and dark brown; lateral lobes dark brown, and sparsely clothed with dark coarse hairs. Wing-covers uniform yellowish brown. Femur light brown, the outer face with darker transverse markings; tibia light brown, thickly clothed with minute dark hairs; base of spines dark brown.—The coloration usually given is, head and pronotum varying from dull yellow to dusky brown, the pronotum usually more or less mottled with dark; wing-covers brownish yellow with a blackish bar on the upper third of the lateral field; legs dull brownish-yellow, often mottled with blackish.

Measurements.—Nova Scotian male (Truro, 12 Aug., 1915): body, 8.3 mm.; pronotum, length, 1.6 mm.; wing-covers, 5.6 mm.; hind femora, 5.3 mm.; hind tibiæ, 4.0 mm.; wing-covers 0.2 mm. shorter than abdomen; hind wings absent.—The measurements of the species usually given are: male: body, 7 mm.; wing-covers, 4.2 mm.; hind femora, 5.3 mm. Female: body, 8.5 mm.; wing-covers, 3.5 mm.; hind femora, 6.2 mm.; ovipositor, 3.8 mm. (Blatchley).

Range.—Nova Scotia, Maine and other parts of New England, south to Florida and Texas, and westward to Neb. It is not common in the northern part of New England (Scudder). Dr. E. M. Walker (1904) does not report it from Ontario, although his common *N. angusticollis* seems to be a somewhat related form.

Occurrence in Nova Scotia.—This small, light-coloured species has not hitherto been reported from Nova Scotia; although it occurs, but not commonly, in Maine. C B. Gooderham has in his collection a single male specimen collected by himself at Truro, Col. Co., on 12th August, 1915, which was identified by Dr. E. M. Walker of Toronto. Prof. W. S. Blatcheley of Indianapolis has also examined the specimen and states it is the "male of what I described as *Nemobius exiguus*, but which according to Rehn is *Nemobius carolinus* Scudder." Mr. Gooderham is convinced that the specimen is correctly determined as *N. carolinus*. It is a pity that Mr. Gooderham's specimen is not a female, as the specific characters are most decisive in that sex. The species is apparently very rare in this province, although it is possible that closer search may show it to be less so than the capture of a single specimen would lead one to suppose. It should be looked for in grass in somewhat similar situations to those frequented by the common *N. fasciatus*, and on sunny grass-covered banks of streams and about fences. Its note is said to be a long, continuous, soft, rolling *whirrrrr*.

Genus Gryllus (Field and House Crickets).

The separation of the native species or supposed species or variants of this genus is a matter which presents great perplexities to specialists, and the subject has been far from on a satisfactory basis. We therefore find considerable difficulty in assigning a precise name to the form which occurs in Nova Scotia, and can only hope that further study may enlighten us so that the matter may be satisfactorily settled. The name herein used, will at least serve tentatively to indicate the variant with which it agrees or is most closely related. This is as near as we can now go. Otherwise we should probably have to adopt the opposite and more generalizing course which will soon be referred to. If the course here selected is open to criticism, it is probably because it is unjustly taken to indicate a disposition to draw fine distinctions in forms which intergrade or which have a strong tendency to do so.

Some fifty-five years ago the forms of *Gryllus* of the New England region bore several names. In 1862 Scudder considered there were five native species there, namely *G. luctuosus* Serv., *abbreviatus* Serv., *angustus* Scudd., *neglectus* Scudd., and *niger* Harr. In 1900 he reduced these to four, namely *G. abbreviatus* (also including his narrow-bodied *angustus*), *luctuosus, pennsylvanicus* Burm. (including *niger),* and *neglectus.* In 1902, in his monograph on the genus (Psyche, vol. 9, p. 291), he brought the number still further down to two, namely *G. abbreviatus* (including also *luctuosus* and *angustus*), and *pennsylvanicus* (including also *nigra* and *neglectus*). Prof. Blatchley in 1903, Dr. E. M. Walker (of Toronto) in 1904, and B. H. Walden in 1911, in the main concurred with this. In 1907 Lutz in his paper on "The Variation and Correlations of Certain Taxonomic Characters of *Gryllus*," surprised us by concluding that species in an anyway natural sense do not exist at all in the genus. In 1915 J. A. G. Rehn and M. Hebard followed this with an article on "The Genus *Gryllus* as found in America" (Proc.

Acad. Nat. Sc., Phila, 67, pp. 293-322), in which after carefully studying 1,540 specimens from North and South America, they finally unite all native American forms of *Gryllus* under one specific name, *Gryllus assimilis* (Fabricius, 1775), the type-locality of which species is Jamaica, and with a range extending from Canada to Patagonia. Simple as this solution of the Gorgon knot may appear, it is doubtful if it will meet with immediate approval, at least from many field orthopterists who are familiar with the habits as well as other points of difference of the various forms in moderately large areas. Their contrary arguments must be heard before a decision is reached. In the meantime until this matter becomes clearer, we will endeavour to fit in with the hitherto prevailing nomenclature. Further remarks on the nomenclature of our Nova Scotian form will be given on page 348.

Considering the very great difficulty of clearly defining between various so-called species, forms, or variants, whichever they may be, the best we can do regarding analytical keys is to give that of Dr. E. M. Walker (1904), founded on metric distinctions, for the determination of Ontario forms, which agrees very closely with the keys of Scudder (1902), Blatchley (1903), and Walden (1911), and which is as good as any that are available along such lines. We must bear in mind, however, that the value of metric diagnostic characters is very much doubted by some recent specialists. Lutz in his paper before referred to, shows the liability to error in using lengths of wing-cover, wing and ovipositor as characters of specific importance in the genus *Gryllus;* and Rehn and Hebard (1915) believe that the mass of evidence on these features in Lutz's paper is absolutely convincing. With this caution, we may say that this key should at least embrace such forms as may occur here, subject to the variation which is met with from region to region. Should subsequent writers sustain Rehn and Hebard's contention that there

is only one native species, *G. assimilis*, in the whole of America, then such keys as this, or better ones to replace them, may be of service as indicative of prevailing phases or variants.

KEY TO NATIVE FORMS OF GRYLLUS IN NORTHEASTERN AMERICA.*
(After Dr. E. M. Walker.)

Black, wing-covers and parts of body sometimes dull reddish-brown; first joint of antennæ not projecting beyond front of head.

a. Ovipositor nearly or fully half as long again as hind femora, usually exceeding 16 mm. [Blatchley and Weldon say exceeding 18 mm.] in length; male stout, with large and broad head. [Not yet reported from Nova Scotia] ....*abbreviatus*.

aa. Ovipositor rarely more than one-fourth as long again as hind femora, seldom if ever more than 14 mm. or less than 12 mm. [Blatchley says 13-14 mm.] in length; male more slender, with narrower and less swollen head.........28. *pennsylvanicus*, p. 341.

Both of these forms are dimorphic as regards length of wing, being termed *short-winged* or *long-winged*, the former being the usual variety.

We should now consider the views of still later writers on these vexed points of difference. Rehn and Hebard (1915) in writing of the variants of their all-embrasive *G. assimilis*, caution us that the characters intermingle in every way and are in no case fixed, so that in their opinion the use of special names to designate the variants is not at all warranted. These writers, however, present the leading characteristics of the variants most frequently encountered and which have hitherto been designated by names. Colour, length of wing-covers and wings, and general size are the only peculiarities considered, other metric comparisons being discarded. The unstable characters of variants occurring in the northeastern and northern regions are compiled as follows from symbolic formulæ given on page 302 of their paper. These characters will hardly bear drafting into a formal key. Their remarks on distribution and intergradation are also given. It may be noted that females, as a rule, have the tegminal and

*The European House Cricket, *Gryllus domesticus* Linnæus, an introduced species, is said to occur in the United States and Canada east of the Great Plains. It has been reported from Toronto (E. M. Walker) and Montreal, and is said to occur sparingly on the southern borders of New England, but has not been found in Nova Scotia. It is distinguished from native species by being straw-coloured, marked with brownish on head and thorax, and by the first joint of the antenna projecting slightly beyond the front of head. It may possibly occur about old stone fireplaces in rural districts.

femoral markings more decided than males; thus frequently in the same series the males will show the ventro-proximal portion of the hind femora varying between being briefly and widely marked with reddish, and the wing-covers entirely black, while the females will on an average show a wide reddish patch on that part of the femora, the wing-covers being dark with the intermediate channel pale. By "small" the authors appear to mean body-lengths from about 17 to 20 mm., and by "medium" those from about 20 to 23 mm.

CHARACTERS OF SOME OF THE MORE PROMINENT VARIANTS OF GRYLLUS.*
(Compiled from Rehn and Hebard.)

neglectus Scudder.—Head and pronotum black; caudal femora black; tegmina normally unicolorous and dark; tegmina slightly reduced, wings very much reduced; size small.—This is the darkest variant of the present species (*assimilis*), the maximum development of the condition seen also in the two following variants. Found in the northeastern portion of the insect's distribution, ranging southward in the high Appalachians to northern Georgia, and is known from the Piedmont Plateau only in Pennsylvania. Much variability exists and every intergradation with the next two variants is often to be found in the same series.

pennsylvanicus Burmeister (other names: *nigra* Harris, *angustus* Scudder).—Head and pronotum black; caudal femora black, with ventro-proximal portion briefly reddish; tegmina normally unicolorous and dark, or else dark with intermediate channel pale, but also ranging through unicolorous and slightly pale, to slightly pale with base and intermediate channel very pale; tegmina slightly reduced, and wings very much reduced, but tegmina often large and wings fully-developed organs of flight; size medium.—This is the dominant variant of the species in well-watered regions of temperate North America and is found southward to the Gulf coast of eastern Texas. Great variability is exhibited and every intergradation exists with the variants termed *neglectus* and *luctuosus*.

luctuosus Serville (other name: *abbreviatus* Serville).—Head and pronotum black; caudal femora black, with ventro-proximal portion widely reddish; tegmina normally unicolorous and slightly pale, but ranging from unicolorous and dark, through various gradations, to slightly pale with base and intermediate channel very pale; tegmina slightly reduced and wings much reduced and concealed by tegmina, but tegmina often large and wings fully-developed organs of flight; size medium.—This variant shows an intensification of the features of the last. It is found throughout the lowlands of the southeastern United States and in the Middle West from Manitoba southward to the arid regions. It also exhibits great variability. The maximum of this condition is found in material from the pine woods of the southeastern United States.

*It must be remembered that Rehn and Hebard discourage altogether the use of names to designate these so-called variants, in forms which they say so completely intergrade.

28. **Gryllus pennsylvanicus** Burmeister. PENNSYLVANIAN FIELD CRICKET. (Shortest-winged form, sometimes called *G. pennsylvanicus neglectus* Scudder.)

Acheta abbreviata (not of Serville). Piers, Trans. N. S. Inst. Sc., viii, 410 (1894); Windsor, N. S.

Gryllus pennsylvanicus form *neglectus*. Piers, Trans. N. S. Inst. Sc., ix, 210 (1896); Halifax, Bedford, and Windsor, N. S.

Gryllus assimilis (Fabricius), in part. Rehn and Hebard, Proc. Acad. Nat. Sc., Phila., 67, 293 (1915).

Note.—Should Rehn and Hebard be sustained in their contention that there is only one species of native cricket in America, then our Nova Scotian form may be termed *Gryllus assimilis* form *neglectus* of Scudder.

In order to clearer understand what relates to this form, I have thought it better to divide what is here presented into two sections; the first describing generally, for comparative purposes, what has been termed *G. pennyslvanicus* in its various forms as found in North America, according to late writers, and the second dealing in detail with the variant which occurs in Nova Scotia.

I. General Description of G. pennsylvanicus *as found in North America.*

Description of G. pennsylvanicus.—Medium-sized and rather broad; male more slender and head more narrow and less swollen (a little wider than pronotum) than in *G. abbreviatus*, pronotum proportionately a little wider and shorter than in *abbreviatus*, length contained in breadth nearly 1.6 times, the width being about 6.3 mm. and length 3.9 mm. in male and about 4.2 mm. in female, the hind margin sinuate.* Wing-covers of male of both short- and long-winged forms, reach to or nearly to tip of abdomen. In female of short-winged variant the wing-covers vary from (a) covering only about two-thirds of abdomen (in what I consider to be *G. pennsylvanicus neglectus* Scudder, which is the form represented in Nova Scotia), to (b) reaching nearly to tip of abdomen, they being about 10 mm. long (in what I consider to be

*In Blatchley's *G. americanus* (=*neglectus*?) the head is no wider than the pronotum, and the length of the latter is contained in its width 1.3 times, the width being 5 mm. in male and 5.6 mm. in female, and the length 3.5 mm. in male and 4.2 mm. in female.

the typical *G. pennsylvanicus pennsylvanicus* Burmeister); while in female of rarer long-winged form they slightly surpass tip of abdomen, being about 12.4 mm. long. Hind-wings in short-winged form are narrower and shorter than wing-covers, and in long-winged form extend considerably beyond as tail-like projections. All these variants are said to intergrade when specimens from various regions or even the same area are compared, and the distinction is probably of little value except for convenience. Hind femora short and stout; hind tibiæ grooved above, with 5 or 6 teeth on each side. Ovipositor seldom if ever less than 12 mm. (Walker) or more than 14 mm. in length, the length being about 1.1 times length of hind femora and rarely more than 1.25 times length of latter.

Colour.—Head shining black; wing-covers varying from deep black to smoky or grayish brown, rarely dull reddish-brown, often with a yellowish-brown line along humeral angle; pronotum, underside of body and legs in freshly-matured specimens, often with minute grayish pubescence which becomes abraded through age, leaving a shining black; hind femora often with basal half of underside reddish-brown; tibiæ and ovipositor black. (The student should also consult the variable colour features, compiled from Rehn and Hebard's paper, on page 340.)

Measurements.—*G. pennsylvanicus* (Blatchley, Indiana). Male: body, 17.5 mm.; pronotum, 3.9 mm.; width of pronotum, 6.3 mm.; wing-covers, 11.5 mm.; hind femora, 12.2 mm. Female: body, 17.1 mm.; pronotum, 4.2 mm.; width of pronotum, 6.3 mm.; wing-covers, 10 mm. (in the short-winged form which I take to be *G. pennsylvanicus pennsylvanicus*) to 12.4 mm. (in long-winged form); hind femora, 12.4 mm.; ovipositor, 13.5 mm.; ovipositor about 1.1 times as long as hind femora.—*G. pennsylvanicus* (Walker, Ontario). Male: body, 17.5 mm.; pronotum, 3 mm.; hind femora, 10 mm. Female: body, 17.5 mm.; pronotum, 3.3 mm.; hind femora, 10.5 mm.; ovipositor, 13.5 mm.; ovipositor about 1.30 times as long as hind femora.—*G. americanus* = *G. neglectus* (?) (Blatchley, Indiana). Male: body, 14 mm. pronotum, 3.5 mm.; width of pronotum, 5 mm.; wing-covers, 7.5 mm.; hind femora, 10 mm. Female: body, 16.5 mm.; pronotum, 4.2 mm.; width of pronotum, 5.6 mm.; wing-covers, 8 mm. (covering 2/3rds of abdomen); hind femora, 11 mm.; ovipositor, 11 mm. (10-12 mm.); ovipositor short, just equalling or rarely exceeding by 1 mm. the length of hind femora.—In the variant which I consider to be the so-called *G. pennsylvanicus neglectus*, and which seems to represent our Nova Scotian insect, the wing-covers reach about or nearly to end of abdomen in male, and only cover about 2/3rds of abdomen in female.

Range.—Scudder in 1902 gave the range of *G. pennsylvanicus* (with which he included *neglectus* and *nigra*), from specimens before him, as from Maine, New Hamp., Mich., Iowa, Nebr., Montana and Br. Columbia, south to Md., Ill., Missouri, Texas, New Mex., Utah and Calif.; but its actual range is slightly more embrasive. Rehn and Hebard (1915) give in effect the range of the variant *neglectus* as the northeastern portion of United States and Canada as far northward as the Field Cricket extends, and thence southward in the high Appalachians to northern Georgia and on the Piedmont Plateau only in Pennsylvania; whereas they say that the variant *pennsylvanicus* (= *nigra* and *angustus*) is the dominant form in the well-watered regions of temperate North America and southward to the Gulf Coast of eastern Texas. In Canada *G. pennsylvanicus*, as such, has been reported from P. E. Island and Ont. (E. M. Walker), Man. (Criddle), Sask. (Caudell), and Br. Columbia (Scudder); and *G. neglectus*, as such, has been reported from Quebec, Montreal and Toronto (Caulfield), and as *G. pennsylvanicus neglectus* from Nova Scotia (Piers) and Moosejaw, Sask. (Caudell). The range of the complex *pennsylvanicus* may therefore generally be taken as extending from southern Canada

through the United States, in non-arid regions from ocean to ocean, south in the central western region to Texas and New Mexico; thus embracing the Canadian to the humid parts of the Upper or Lower Austral Zones; whereas the form *neglectus* is more nearly restricted to the Canadian and Transition Zones and mostly is found in the northeastern and eastern areas. Long-winged forms are usually uncommon, and in Canada have only been taken once (Ontario). None of the forms have been found in Newfoundland. Scudder in 1900 reported *neglectus* as common in the southern half of New England at least, and *pennsylvanicus* as common in the same half; while he states that *abbreviatus* and *luctuosus* are common everywhere in that region.

2. *The Variant occurring in Nova Scotia.*

Name of Nova Scotian variant.—From such Nova Scotian specimens as are at hand as I write, and measurements of others sent me by C. B. Gooderham of Truro, I find that they generally agree most closely with the very short-winged form sometimes known as *neglectus* of Scudder, with probably a slight tendency in a very few specimens towards the ordinary short-winged form termed *pennsylvanicus* of Burmeister with which it is closely affiliated and with which it probably intergrades in other regions. We may tentatively, therefore, and as a mere matter of present convenience, refer to our form as *Gryllus pennsylvanicus neglectus* Scudder. Further remarks on this point will be made on page 348.

Description of Nova Scotian specimens.—The size varies from very small to medium for *Gryllus*, but averages small (length 18.5 mm. in males, 19.2 mm. in females); the greater extremes in length being found in females. Breadth of female abodmen usually about one-third length of body. Apparently all before me have greatest width of the head slightly less than greatest width of pronotum by from .17 to .75 mm. Pronotum but little if any narrower in front than behind, its average "length" contained in its "width" 1.50 times; the front margin slightly concave and sometimes ciliate, hind margin slightly convex, lateral margins of disk nearly straight but tending to convexity; an impressed line very close to and parallel to front and hind margins, and a longitudinal median impressed line distinct on a little more than half of its anterior part. The wing-covers of female cover from a little less than 6/10ths to a little less than 8/10ths of abdomen as measured from hind margin of pronotum to tip of abdomen, and average only 65/100ths or 2/3rds. Those of male usually cover more of abdomen than those of the other sex, ranging from 6/10ths to 1 1/10th, and averaging 82/100ths. It is rarely they slightly exceed the abdomen in male and never in female. The inner edges of wing-covers overlap for their entire length in males; but in some females, perhaps late in the season, they are more or less separated at their ends so as to form a Λ-shaped notch, but all gradations are found from unnotched to notched state, and it is possible the latter may be caused to some extent by the degree of distension of abdomen.* Only the short-

*Blatchley has made this notch one of the characters of his *G. americanus*, which apparently is the same as Scudder's *neglectus*.

winged form, with the hind-wings considerably shorter than wing-covers, has been met with in this province; and it is generally the variety with decidedly shorter wing-covers, covering on an average only about 2/3rds of the female abdomen, which I take to be the variant termed *neglectus* by Scudder. I have noted only two females (*a* and *f*) with wing-covers very slightly exceeding 3/4ths of abdomen, and these may show a tendency towards a passage to the ordinary short-winged *pennsylvanicus* in which the wing-covers of the female reach nearly to the tip of abdomen. Hind femur stout, averaging 10.3 mm. in length, and 3.3 mm. in greatest width; its length contained in length of ovipositor from 1.17 to 1.47 times, averaging 1.32 times. The hind tibia usually has 6 pairs of stout spines and a few additional spines at the extremity. The ovipositor ranges from .57 to .95 times length of body, and averages .72; in no specimens does it exceed the body length. The actual length of ovipositor varies from 12.2 mm. to 15.2. mm., the average being 13.69 mm.

Colour of Nova Scotian specimens.—From my notes I transcribe the following colour descriptions of seven females and one male which are fairly typical of our form. The measurements of each specimen will be found in the general table of measurements on pages 345 and 346—*Two females* (*e* and *f*) taken on roadside at Halifax, 5th and 7th Sept., 1897. General colour black, with fine grayish pubescence on pronotum, femora and some other parts; head shining black; antennæ black; wing-covers shining black with a light-coloured line on lateral ridge where they bend downward onto sides; light-coloured veins on lateral part (costal area or portion bent down) of wing-covers; ovipositor brownish. This description was noted immediatly after the specimens were taken. My notes make no mention of any reddish tint on the femora, and therefore most likely they were unicolorous. (Size small; body, 18.5 and 18.2 mm.)—*Four females* (*a*, *b*, *c*, and *d*), taken on King's Meadow, Windsor, Hants Co., Sept., 1892, and determined in 1895 as *G. pennsylvanicus neglectus* by W. Beutenmüller, furnish the following colour-description on re-examination after being in alcohol for many years: Upper parts black, under parts with a brownish tinge; a slight grayish pubescence on some of upper parts, but not at all general; dorsal and median areas of wing-covers rather pale sepia-colour or dark broccoli-brown, with dark sepia veins or nerves (darker than the ground-colour); costal area of wing-covers, or portion turned downward, dark sepia with broccoli-brown veins (lighter than ground-colour); a paler, buffy, narrow line on humeral angle or lateral ridge of wing-covers; femora black or dark brownish-black, sometimes slightly paler on proximal fifth of inner face; tibiæ brownish-black; ovipositor brown-black; antennæ black near head, becoming brown anteriorly. These four specimens have no doubt faded somewhat in the preservative fluid. (Size very small to small, 14.75 to 17.30 mm.)—*One female* (*g*), taken on road at Kentville, Kings Co., 13th Oct., 1915. Shining black, no pubescence anywhere; wing-covers pale clay-colour with liver-brown veins, the light colour being most noticeable as a very obscure stripe on lateral ridge and extending backward until lost; femora with a chestnut or hazel-coloured area on both outer and inner faces, on basal lower two-fifths, and gradually passing into the adjacent blackish colour of remainder of limb. (Size small, 19.0 mm.)—*One male* (*s*) taken beneath a stone on roadside, Halifax, 7th Sept., 1897, in company with one of the before-mentioned females (*f*), was coloured just as was that female, except that there was apparently no light-coloured line on the lateral ridge of wing-covers and no light-coloured veins on their costal area. Structurally, of course, it showed the differences which are seen in the sexes of field crickets, the male being proportionately much narrower in the body, and the raised veins on wing-covers being differently disposed. (Size very small; body, 15 mm.)

It may be added that many females and most of those from about Truro show a chestnut or hazel-coloured area on about one-third or two-fifths of the lower basal portion of the outer and inner faces of the hind femur, that on the outer face being considerably narrower and slightly longer than that on the inner one; this reddish tint graduating into the adjacent blackish colour. Some of the females exhibit this colour only on the inner face and lower edge of femur. Males do not seem to have this reddish mark on the outer face of the femur; but it is often seen, but very much less extensively than in the other sex, on the lower basal portion of the inner face and sometimes slightly on the lower edge. It may be noted that females of *Gryllus* as a rule have the tegminal and femoral markings more decided than in males.

Detailed measurements of Nova Scotian Specimens.—The following is a comparative table of measurements in millimetres of specimens of the Short-winged Pennsylvanian Field Cricket collected in this province:—

MALES

Designation	r	s	t	u	v	w	x	y	Males, Average, 8 Specimens
Locality	Bedford	Halifax	Truro						
Date	2 Sep. '96	7 Sep. '97	7 Sep. '14	1 Sep. '15	31 Aug '14	9 Oct. '13	18 Oct. '16	18 Oct. '16	
Collection*	P	P	AC	AC	AC	G	G	G	
	Millimeters.								
Body, length	17.0	15.0	18.9	18.5	16.7	17.2	20.0	21.1	18.5
Pronotum, length	3.2	—	3.3	3.5	3.0	3.4	3.2	3.4	3.2
Pronotum, width	5.0	—	5.0	5.6	5.1	5.0	5.0	5.0	5.1
Abdomen, from hind margin of pronotum	10.0	11.2	11.6	12.6	11.8	11.8	14.6	15.7	12.4
Wing-cover**	11.0	9.0	10.0	10.8	10.0	8.8	9.0	10.9	9.9
Wing-cover shorter (—) or longer (+) than end of body	+1.0	—2.2	—1.6	—1.8	—1.8	—3.0	—5.6	—4.8	—2.8
Hind femur	10.5	10.0	—	10.7	9.4	10.0	9.7	10.0	10.01
Hind tibia (exclusive of spines)	7.0	—	—	8.3	7.3	7.3	7.2	8.0	7.5
Percentage of abdomen covered by wing-covers	110	81	85	86	85	75	62	69	82 or 13/16
Absence or presence of Λ-shaped notch between ends of wing-covers	No	No	No	No	No	No	No	No	

*Collection: P = Piers; A C = Agricultural College, Truro; G = Gooderham, Truro.
**All hind wings are shorter than wing-covers.

FEMALES

Designation	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	Females, Average, 17 Specimen
Locality	Windsor				Halifax		Kentville	Truro										
Date	Sept., 1892.				5 Sep. '97	7 Sep. '97	13 Oct. '15	7 Sep. '14	—	—	—	4 Oct. '13	7 Sep. '14	18 Oct. '16	18 Oct. '16	18 Oct. '16	18 Oct. '16	
Collection*	P	P	P	P	P	P	P	AC	AC	G	G	G	G	G	G	G	G	
	Millimeters																	
Body, length	14.7	17.3	16.5	16.7	18.5	18.2	19.0	18.4	21.3	17.1	20.9	16.7	21.2	23.7	22.6	22.9	21.9	19.27
Pronotum, length	3.0	3.6	3.0	3.4	—	—	3.3	3.5	4.0	3.3	4.0	3.4	3.7	4.0	4.0	3.8	3.3	3.55
Pronotum, width	4.9	5.5	4.6	5.5	—	—	5.2	5.0	6.0	4.8	5.8	5.2	5.3	5.9	5.1	5.5	5.5	5.32
Abdomen, from hind margin of pronotum	9.6	12.5	11.5	13.5	14.7	13.0	12.4	13.1	15.0	11.8	14.1	10.3	15.2	16.8	16.5	17.0	16.3	13.72
Wing-cover**	7.5	8.5	6.9	8.0	10.0	10.0	7.2	8.1	10.5	7.8	10.5	7.2	8.9	10.5	10.0	9.8	9.3	8.86
Wing-cover shorter (—) or longer (+) than end of body	—2.1	—4.0	—4.5	—5.5	—4.7	—3.0	—5.2	—5.0	—4.5	—4.0	—3.6	—3.1	—6.3	—6.3	—6.5	—7.2	—7.0	—4.86
Hind femur	9.5	10.6	9.4	—	—	11.5	10.5	—	—	9.8	11.0	9.2	—	11.0	10.5	10.4	10.1	10.30
Hind tibia (exclusive of spines)	7.0	7.5	7.5	—	—	—	8.0	—	—	7.0	7.9	7.3	—	9.0	—	8.1	8.0	7.73
Ovipositor	14.0	14.0	12.9	14.1	15.2	15.2	12.3	13.0	13.9	12.2	14.2	13.4	13.6	15.0	13.5	13.0	13.3	13.69
Hind femur contained in ovipositor; times	1.47	1.32	1.37	—	—	1.32	1.17	—	—	1.25	1.29	1.47	—	1.36	1.29	1.25	1.32	1.32
Percentage of abdomen covered by wing-covers	77	68	60	59	68	77	58	62	70	66	74	70	59	63	60	58	57	65 or ⅔
Absence or presence of Λ-shaped notch between ends of wing-covers	No	No	Yes	No	No	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Gradate

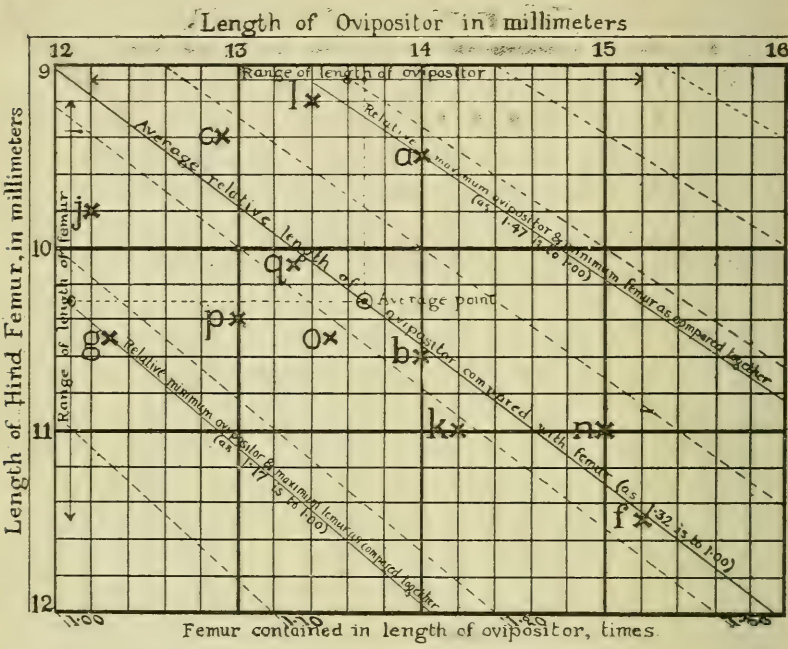
*Collection: P = Piers; AC = Agricultural College, Truro: G = C. B. Gooderham, Truro. **All hind wings are shorter than wing-covers.

Females *a* to *d* were taken on King's Meadow, Windsor, Hants Co., Sept., 1892 (see colour-description previously given; these four specimens determined in 1895 as *G. pennsylvanicus neglectus* by Wm. Beutenmüller of the Am. Museum of Nat. Hist., N. Y., author of Descriptive Catalogue of Orthoptera of New York, 1894); female *e*, Dutch Village Road, Halifax, 5 Sept 1897 (see colour-description); female *f*, Quinpool Road, Halifax, 7 Sept. 1897 (see colour-description; taken in company with male *s*); female *g*, Kentville, Kings Co., 13 Oct. 1915 (see colour-description); females *h* to *q*, Truro, Col. Co., various dates Sept. and Oct. (some of them and of the preceding with notch between ends of wing-covers as in Blatchley's *G. americanus*); *n* to *q* were full of eggs and were measured from specimens preserved in formaline; male *r*, Rifle Range, near Bedford, Hx. Co., 2 Sept. 1896 (determined as *G. pennsylvanicus neglectus* by Beutenmüller); male *s*, Quinpool Road, Halifax, 7 Sept. 1897 (see colour-description; taken in company with female *f*); males *t* to *y*, Truro, Col. Co., various dates, Aug. to Oct., *x* and *y* being measured from specimens preserved in formalin. The measurements of the Truro specimens have been supplied by Mr. Gooderham.

Extreme and average measurements of Nova Scotian specimens.—As compared with various forms of American *Gryllus*, the males and females of our Nova Scotian variant vary in size from very small to medium, and average small in both sexes. The variation in size is considerably greater, however, in females than in males.—*Males* (8 specimens): length, 15.0-21.1 mm. (average 18.5 mm.); pronotum, length, 3.0-3.5 (average, 3.29); pronotum, width, 5.0-5.6 (average, 5.1); abdomen from hind margin of pronotum, 10.0-15.7 (average, 12.4); wing-covers, 8.8-11.0 (average, 9.94); wing-covers from 5.6 mm. shorter than end of abdomen, to 1.0 mm. longer than end of abdomen (average, 2.8 shorter); wing-covers cover from 6/10ths to 1 1/10th of the abdomen (average, 8/10ths); hind femora, 9.4-10.7 (average, 10.04); hind tibiæ, 7.0-8.3 (average,7.5); anal bristles, 5.5-7.0 (in *r* and *s*).—*Females* (17 specimens): length, 14.75-23.7 mm. (average, 19.27 mm.); head, length, 2.7-3.0 (average, 2.87); head, width, 4.1-5.0 (average, 4.71, in *a-d*); pronotum, length, 3.0-4.0 (average, 3.55); pronotum, width, 4.6-6.0 (average, 5.32); abdomen from hind-margin of pronotum, 9.6-17.0 (average, 13.72); wing-covers, 6.95-10.5 (average, 8.86); wing-covers from 2.15 mm. to 7.2 mm. shorter than end of abdomen (average, 4.86 mm.); wing-covers cover from 57/100ths to 77/100ths of abdomen (average, 65/100ths or 2/3rds); hind femora, length, 9.2-11.5 (average, 10.3); hind femora, greatest width, about 3.3; hind tibiæ, 7.0-9.0 (average, 7.73); ovipositor, 12.2-15.2 (average, 13.69); hind femora contained in length of ovipositor, 1.17-1.47 times (average, 1.32 times); antennæ, 33 mm. (in female *e*) and 28.5 (in female *f*). In all specimens, male and female, the hind-wings are shorter than the wing-covers; the hind-wings being 8.0 mm. long in one female (*e*) which was measured, in which the wing-covers were 10.0 mm. None of the males have a Λ-shaped notch between the ends of the wing-covers; but in the females, 9 have such a notch more or less developed, while 8 are more or less without the notch, although in this feature complete intergradation is seen.

The following diagram illustrates graphically the relative length of the ovipositor as compared with that of the hind femur in twelve Nova Scotian females, about which such data are available, and makes clearer the range of departure from the normal proportions of those members as found in specimens in this province. It will be seen that specimens *b*, *q* and *f* approach nearest to the normal or average line, while the maximum departures are found in specimen *a* which exhibits the relative longest ovipositor, and in *g* which exhibits the relative shortest ovipositor as compared with the femur. The longest ovipositor, apart from comparisons with the femur, is actually found in specimen *f*, and the shortest one in *j*; while the longest femur is in

specimen *f*, and the shortest in *l*. Detailed measurements of each of the specimens are given in the full table of measurements on page 346.



Gryllus pennsylvanicus neglectus: Nova Scotian females.

Diagram illustrating the Relative Length of Ovipositor to that of Hind Femur. The letters are those designating the particular specimens in the preceding table of measurements.

Longest ovipositor actually, specimen *f*; shortest ovipositor actually, specimen *j*; longest hind femur actually, specimen *f*; shortest hind femur actually, specimen *l*. Longest ovipositor compared proportionately with length of hind femur, specimen *a*; shortest ovipositor compared with hind femur, specimen *g*. Specimens nearest normal, *f*, *b*, *q*.

Nomenclatural remarks on the Nova Scotian form.—To sum up the question of nomenclature, I have no doubt that our common Nova Scotian Field Cricket is a shorter-winged variant of the form which has hitherto been known as *Gryllus pennsylvanicus*. Furthermore, without at all desiring to hold to an older nomenclature or to what may be an untenable hair-splitting of names in a genus the members of which, as we have seen, are being gradually bulked

together by specialists, I have decided, tentatively at least and as a matter of convenience, to place our form under the old name *Gryllus pennsylvanicus neglectus* of Scudder, for with that variant or subvariant it seems mostly to agree. No doubt the variants intergrade in various parts of America, and therefore their characters are of slight real classificatory value. My belief that our form is nearest Scudder's *neglectus*, is perhaps a matter of very unnecessary detail, and quite open to criticism at the present time when *neglectus*, once held to be a separate species, has become to most students a mere transitory phase of *pennsylvanicus*, and when, as we have noted on page 338, even all the American native forms of *Gryllus* have been by the two well-known authorities, Rehn and Hebard, very recently thrown together under one specific name, *assimilis* of Fabricius, those writers maintaining that all forms and colour-phases intergrade over wide areas. Still in a purely local paper like this, it is perhaps better for the present to endeavour to draw minor or closer distinctions, and so risk the charge of being over-exact; leaving to systematists with a much wider vision and material from extensive geographic areas, the task of finally assigning the form where it properly belongs, an undertaking which will probably be the easier for them because of such initial detailed treatment.

I may say that by *neglectus* I understand a rather small-sized, distinctly short-winged variety of the complex *pennsylvanicus*, in which the wing-covers of the female cover on an average only about two-thirds, or a trifle less or more, of the abdomen, and in which the ovipositor averages about 14 mm. or a little less in length and also averages less than half as long again as the hind femur. In the other short-winged or typical *pennsylvanicus* the wing-covers are considerably longer, reaching nearly to the end of the abdomen in the female.

Scudder's original description of *G. neglectus* (Boston

Journ. Nat. Hist., vol. 7, p. 428, 1862) may here be reproduced for comparison, as it is not accessible in most libraries:

"This is our most common species..... The head, thorax, and body, as well as the hind femora, are pitchy black, the elytra of both male and female are dark, sometimes jet black, but frequently of quite a light ochraceous brown; indeed, the elytra of almost all our species vary to this extent in coloration; the elytra of the females generally cover about two-thirds of the abdomen, although sometimes they entirely conceal it; those of the males extend to the extremity of the abdomen; the ovipositor in this species is proportionately shorter than in either of the preceding species [that is, *G. luctuosus, abbreviatus* and *angustus*], and is also a smaller species than any of the preceding. Length averaging a little more than half an inch; length of ovipositor in nine individuals .23 [i. e. .46 in. = 11.5 mm.] to .32 in. [i. e. .64 in. = 16.0 mm.], average .28 in. [i. e. .56 in. = 14.2 mm.]; length of hind femora, .16 [i. e. .32 in. =8.0 mm.] to .21 in. [i. e. .42 in. = 10.5 mm.], average, .20 in. [i. e. .40 in. = 10.00 mm.]"* [It will be observed that the length of the ovipositor averages 1.4 times the length of the femur; while in *niger* he gives it as only 1.11, in *angustus* and *abbreviatus* as 1.68, and in *luctuosus* as 1.55 times.]

Our form generally seems to agree most nearly with *neglectus* of Scudder, although a few specimens may show a tendency towards intergradation with the ordinary short-winged *pennsylvanicus* with somewhat longer wing-covers. Scudder in his paper just quoted, seemed mostly to rely on metric differences. Rehn and Hebard, along with other features, draw some attention to the all-black hind femora and normally dark unicolorous wing-covers of the *neglectus* variant; and to the brief reddish patch on the ventro-proximal portion of the femur and the dark or paler wing-covers of the *pennsylvanicus* variant. (See page 340). As we have seen, many of our specimens have a reddish patch on the femora.

As to the claim of *neglectus* to any recognition whatever, it may be mentioned that A. N. Caudell of the U. S. Department of Agriculture, in 1904-05 held that the smaller size and shorter wing-covers of Scudder's *neglectus* certainly entitle it to varietal distinction, and he refers to it trinomially as *G. pennsylvanicus* var. *neglectus*, even though Scudder himself, in 1902 had subordinated it as a synonym of Burmeister's *pennsylvanicus* (Can. Ent., vol. 36, p. 248, 1904;

*I have doubled the lengths of ovipositor and femur as given by Scudder, for the reason that it is now known that he inadvertently used a half-size scale when measuring his forms of *Gryllus* in the paper of 1862. This has been pointed out by Caudell and other writers.

and Proc. U. S. Nat. Mus., vol. 28, p. 477, 1905). As late as 1910, Rehn and Hebard themselves, writing of *G. neglectus*, said that this form appears worthy of some designation whether specific or varietal (Proc. Acad. Nat. Sc. Phila., vol. 62, p. 647, 1910); and in 1915 they speak of *neglectus* and *pennsylvanicus* as two of the nine most frequently encountered, but unfixed, variants of *G. assimilis*, under which latter name they finally place all the variants (Proc. Acad. Nat. Sc. Phila., vol. 67, p. 302, 1915). They however advise against the use of special names to designate such variants. We may for the present conclude that *neglectus* is at least a convenient tentative name, although of very minor rank, and as such I have used it here.

I do not feel inclined to say that the form which has been known as the typical *G. pennsylvanicus* (such as described by Blatchley for instance) has yet been found in Nova Scotia, although a very few of our specimens show a slight tendency towards intergradation with that variant. Scudder in 1900 reported *pennsylvanicus* (=*niger* of his older list) as common in the southern half of New England. The so-called *abbreviatus* of authors, one would rather expect to find here, as Scudder in 1900 said it is common everywhere in New England; but it has not yet been reported from the Maritime Provinces, and I have met with nothing to cause me to include its name among our Orthoptera.

Occurrence in Nova Scotia.—The Short-winged Pennsylvanian Field Cricket, which I consider to be the variant previously known as *Gryllus pennsylvanicus neglectus* of Scudder, varies in abundance from rather common to very common in Nova Scotia, although it is not so excessively abundant as its lesser relative the Short-winged Ground Cricket (*Nemobius fasciatus*). It was not, however, definitely recorded from this province until 1896.* I have never

*In 1894 I had reported it from Windsor, N. S., under the erroneous name of *Acheta abbreviata* (Trans. N. S. Inst. Sc., 8, 410). Strange to say F. Walker did not report it from Nova Scotia in his list of the Orthoptera of Canada (Can. Ent., iv, 1872). Walter Bromley's mere reference, in 1825, to "crickets" as occurring in Nova Scotia is altogether indefinite.

found the long-winged form here, although I have examined very many specimens, nor has C. B. Gooderham of Truro, and there are none of that form in the collection of the Agricultural College.

While rather common about Halifax, this cricket is not nearly so abundant here as in the western parts of the province, where in some districts at least it is excessively common. Although not often seen unless looked for, it is, however, moderately plentiful about this town, and not at all so rare as I supposed it to be when I prepared my previous paper. I have noted it at Westville, Pict. Co., in the middle of Sept., 1901, and no doubt it extends into Cape Breton Island, as it occurs also in Prince Edward Island, where it has been recorded as *G. pennsylvanicus*.

In the vicinity of Halifax it is usually found on dry, sloping banks, with scant vegetation and therefore somewhat earthy and having some flattish stones scattered about, on country roadsides, the borders of fields, and similar places. It does not seem to congregate in numbers much about here; but is usually met with in pairs, a male and a female, under small stones, and when the stone is lifted it runs rapidly about, this way and that, in a bewildered manner, looking for a hiding place or its little burrow. Its leaping power is plainly not so great as that of *Nemobius*, and it makes but short jumps, and prefers if possible to find a place of concealment by running away. Its timidity and secretive nature causes it to be seldom seen about Halifax; but its notes draw attention to its hiding-place beneath a stone or piece of rubbish, where it can easily be captured.

In the western part of the province it is much more numerous, more in evidence and less secretive, and is probably more social, being oftener seen with others of its kind about pastures as well as roadsides and banks. I observed it in immense numbers everywhere in the rather short grass

of the expansive King's Meadow, near King's College, Windsor, Hants Co., early in Sept., 1892, when it had laid aside almost all timidity, only moving from an approaching foot when the latter threatened to crush it;* and in large numbers on the sparsely-grassed banks on the margin of dyked pasture-land at Kentville, Kings Co., in the middle of October, 1915; as well as at other places in the western districts. Its abundance at those places far exceeded that found anywhere about Halifax. It is possible that it may be more liable to congregate in the latter part of the autumn in some localities.

The eggs are deposited in loose soil in the latter part of the autumn; and as females taken at Truro, Col. Co., on 18th Oct., 1916, were full of eggs, that date no doubt indicates approximately the time of oviposition. The eggs hatch the following year, possibly early in June or thereabout, as on 5th June, 1915, Mr. Gooderham says he observed at Truro a few newly-hatched nymphs of an undetermined cricket but which was either this form or *Nemobius fasciatus*, both of which no doubt hatch about the same time. They moved and leaped rapidly, and until examined closely might have been mistaken for a flea-like insect. I have never noted adults in the spring or early summer, as in Ontario and other places to the south where nymphs hibernate to some extent.

If this cricket does hatch early in June, adults should be about during the lattermost part of July; but if so they must be silent at that time, as I have not noted them then. Its notes or shrilling, which are produced in a similar manner to those of *Nemobius*, are apparently first heard near Halifax about the 2nd August,† and approximately at the same time as those of the smaller cricket, although at first I find it difficult to distinguish the notes of the larger species, as both call very faintly at that time. They are frequently heard during both day and night in suitable places; but by October

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*With it was *N. fasciatus*, but the larger species far outnumbered the smaller one.

†2 Aug., 1897, 6 Aug 1916. The doubtful date "17 (?) July" given for first appearance of adult *G pennsylvanicus* in table on page 232, should read *about 2nd Aug.*

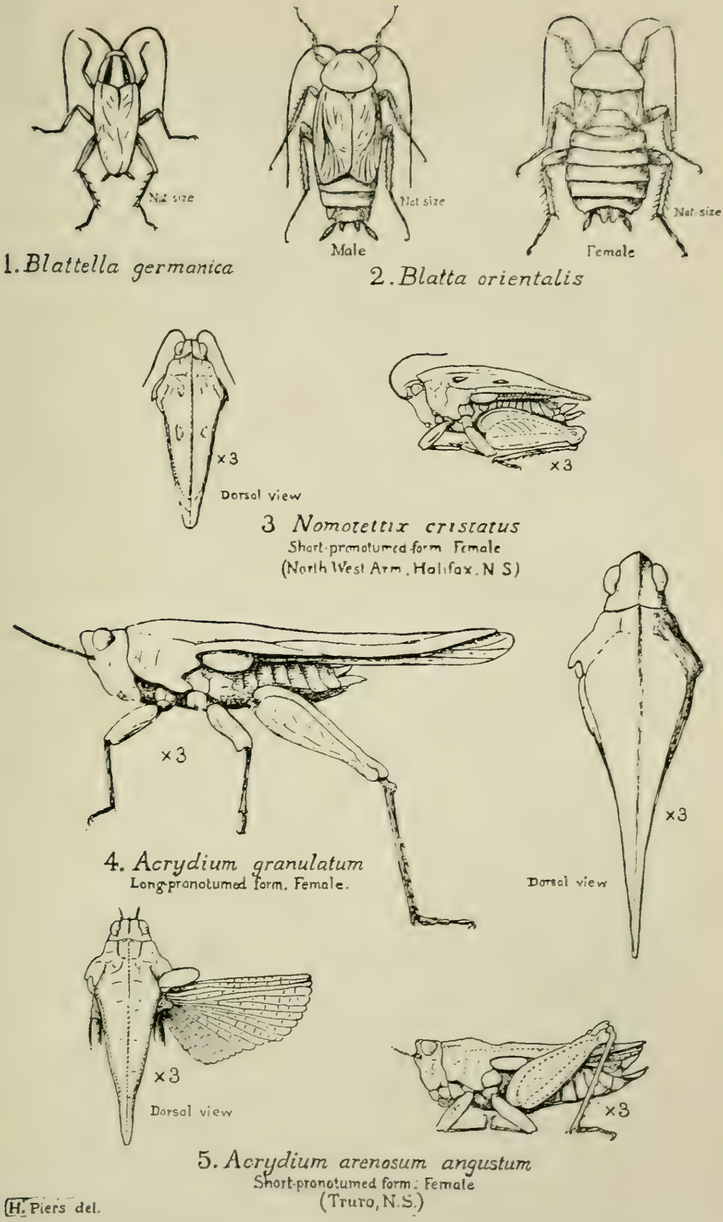
the number heard has much lessened in daytime and few or none shrill at night; and often none are noted during some days in the latter part of that month, although the little *Nemobius* is then chirring. The last one heard in 1897 was on 5th Nov., about noon, it being a fine sunny day although a hoar-frost had occurred the previous night. The period of their stridulation, therefore, is about coincident with that of *Nemobius;* and like the latter, this insect is rather silent during dull days.

A close observer can readily learn to distinguish the shrilling of the larger cricket, when in full song, from that of *Nemobius,* although they have many tonal characteristics in common. The note of our *Gryllus* is considerably louder, and is a shorter, slower-timed, and more distinct and noticeable trill than that of its smaller relative. It sounds like the trilled syllable *plee-e-e.* After each such trill it is silent for a moment and then calls again, thus: *plee-e-e; plee-e-e;* and so on. These notes sound out distinctly louder and more staccata from the omnipresent undertone and lower-toned tremolo resultant from the intermingled shrilling of countless numbers of *Nemobius* on all sides. When both species call more faintly at the beginning of the season, it is much more difficult to differentiate between the two.

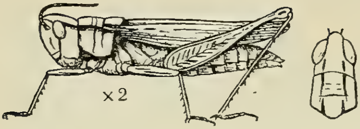
No doubt this species does considerable damage to pasture land in the western parts of the province, but about Halifax its abundance is not sufficient to make it a pest to the agriculturist, the Striped Ground Cricket being the one which creates most injury in the latter district.

ADDENDA

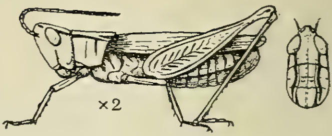
Page 268. A nymph of *Chorthippus curtipennis* (green phase) in about 4th stage was taken at the head of the North West Arm, Halifax, 23 June, 1918. —Page 306 and 232. Nymphs of *Melanoplus bivittatus* in about 1st, 2nd and 3rd stages, and from 5½ to 14 mim. long, were taken at the head of the North West Arm, 22-23 June, 1918. Hoar frost and ice ⅛ inch thick formed there on morning of 21 June.



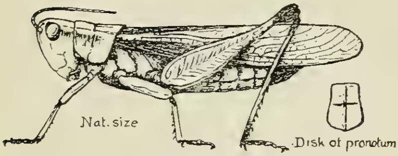
ORTHOPTERA OF NOVA SCOTIA.
(To illustrate paper by H Piers)
The numbers are the same as those preceding the name of the species in the text of the paper.



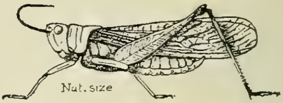
6. *Orphulella speciosa*
Female



7. *Chorthippus curtipennis*
Male

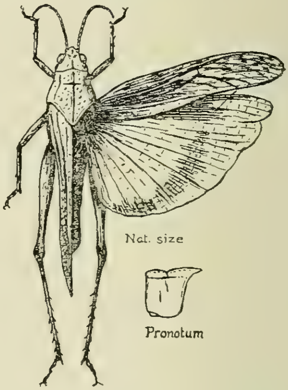


8. *Mecostethus lineatus*
Female

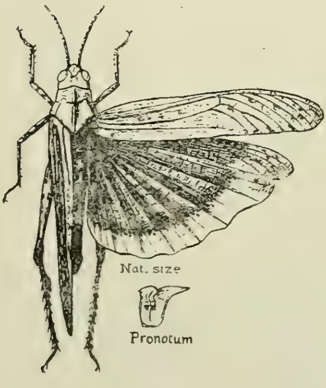


9. *Mecostethus gracilis*
Male
(Cow Bay, Hx.)

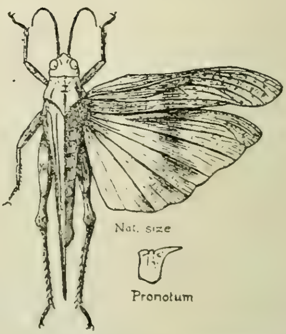
10. *Camnula pellucida*
Female



11. *Hippiscus apiculatus*
Male



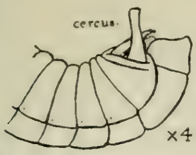
12. *Dissosteira carolina*
Male



13. *Circotettix verruculatus*
Female

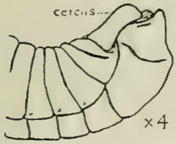
H. Piers del.

ORTHOPTERA OF NOVA SCOTIA.
(To illustrate paper by H. Piers)
The numbers are the same as those preceding the name of the species in the text of the paper.



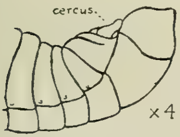
14. *Podisma glacialis*
Male
(Side view of end of abdomen)

15. *Melanoplus atlanis*
Male

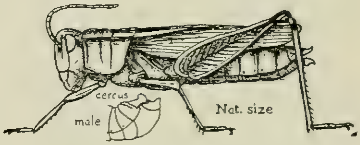


16. *Melanoplus fasciatus*
Male

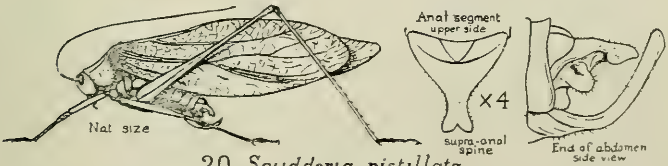
17. *Melanoplus femur-rubrum*
Male



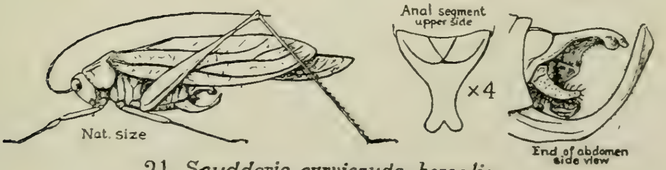
18. *Melanoplus extremus*
Male



19. *Melanoplus bivittatus*
Female



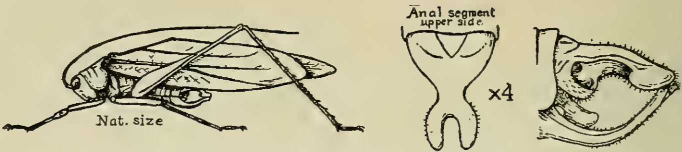
20. *Scudderia pistillata*
Male
(Chocolate Lake, Halifax, 10 Sep. 1916)



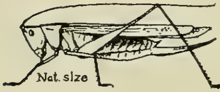
21. *Scudderia curvicauda borealis*
Male
(Wilmot, N.S., 6 Sep. 1915)

I. Piers del.

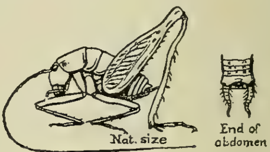
ORTHOPTERA OF NOVA SCOTIA.
(To illustrate paper by H. Piers)
The numbers are the same as those preceding the name of the species in the text of the paper.



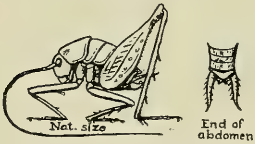
22. *Scudderia furcata furcata*
Male, Chocolate Lake, Halifax, 30 Sep., 1897
Specimen B



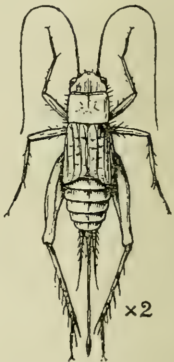
23. *Conocephalus fasciatus fasciatus*
Female



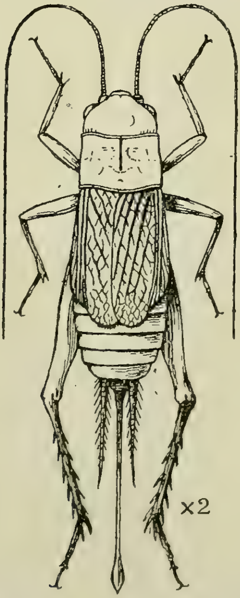
24. *Ceuthophilus maculatus*
Male



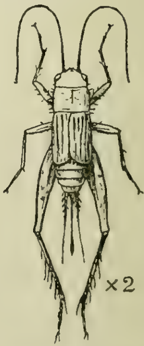
25. *Ceuthophilus terrestris*
Male



26. *Nemobius fasciatus*
Short-winged form. Female



28. *Gryllus pennsylvanicus*
Shortest-winged form *(neglectus)* Female
Average Nova Scotian specimen



27. *Nemobius carolinus*
Female

H. Piers del.

ORTHOPTERA OF NOVA SCOTIA
(To illustrate paper by H. Piers)
The numbers are the same as those preceding the name of the species in the text of the paper.

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"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society."

THE

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Price to Non-Members: One Half-Dollar

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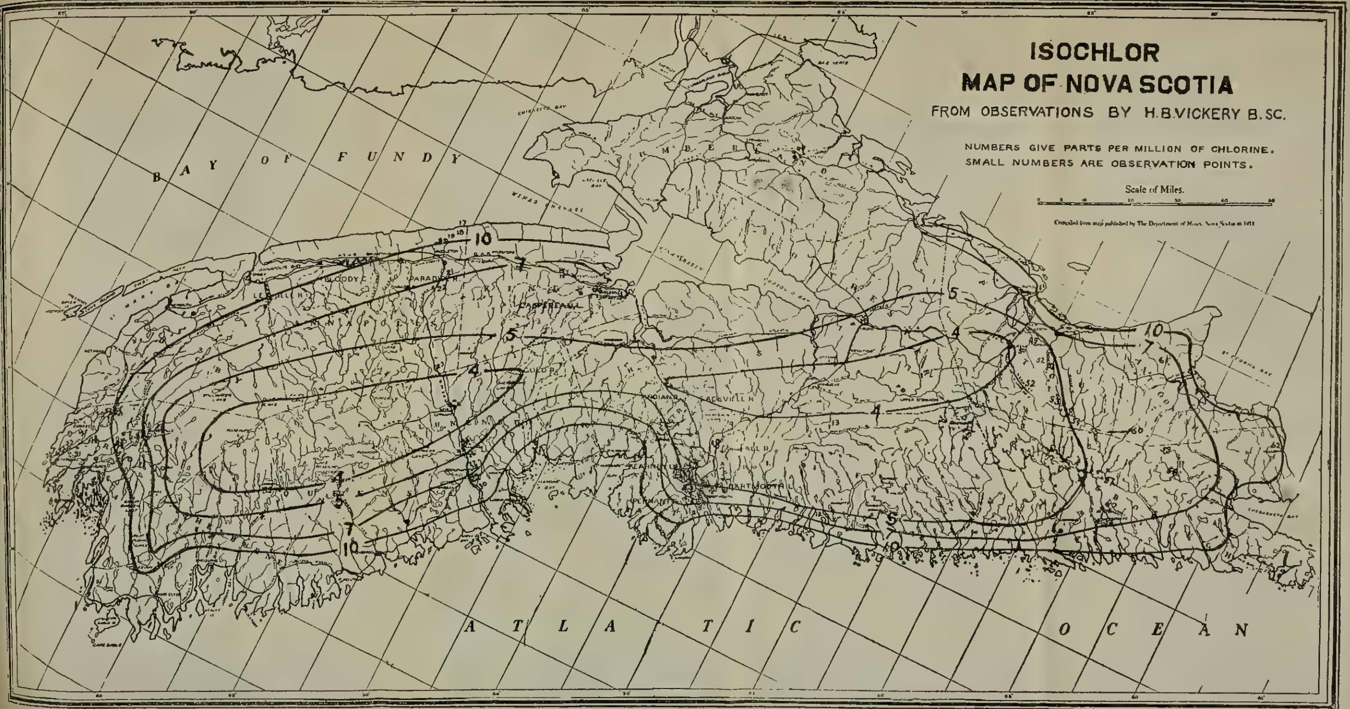

ISOCHLOR
MAP OF NOVA SCOTIA
FROM OBSERVATIONS BY H.B.VICKERY B.SC.
NUMBERS GIVE PARTS PER MILLION OF CHLORINE.
SMALL NUMBERS ARE OBSERVATION POINTS.
Scale of Miles.
BAY OF FUNDY
ATLANTIC OCEAN

TRANSACTIONS

OF THE

Nova Scotian Institute of Science

SESSION OF 1917-1918.

(Vol. XIV Part 4)

The Isochlors of Nova Scotia—By Hubert Bradford Vickery, M. Sc., Halifax, N. S.

Introduction.

The object of this research is to determine the normal chlorine content of spring and brook waters of Nova Scotia. By normal chlorine content is meant the amount of chlorine, chiefly as sodium chloride, found in unpolluted waters that may be considered to have been taken up by the water from the soil of the surrounding area. This chlorine content is estimated along certain lines crossing the region, and points having the same content are connected by lines on a map of the region. These latter lines are therefore Isochlor Lines, or shortly Isochlors, (just as we have isobars, isotherms, etc.).

Sources of Chlorine.

There are probably three main sources from which this chlorine is derived—chlorine mineral deposits, the sea and sewage. According to the "Report of the Salt Deposits of Canada and the Salt Industry", prepared by Heber Cole, B. Sc. (No. 325 of the publications of the Departments of Mines of Canada), there are nine separate salt spring regions in the Province of Nova Scotia. Of these four are in Cape

Breton, notably that at Whycocomagh. In the peninsula the largest springs are at Antigonish, but there is a small spring at Walton, Hants County, with a percentage of a trifle over unity. At Salt Springs, Pictou County, there is a spring yielding 5.9 per cent. of salt, and at Cheverie, Hants County, deep borings through gypsum gave strong brines. Also there is a brine spring at Springhill. These isolated points, however, probably have very little effect upon the normal chlorine lines as herein determined, though an observation of Mr. Cole's states that salt is very often found associated with gypsum, and this may contribute in some measure to the rather wide areas between the normals along the Annapolis Valley as compared with those along the Atlantic Coast.

With the introduction of chlorine by means of sewage we have nothing to do in this paper, because the estimations were made on water taken from sources as far as possible from any probable animal polution. The influence of the sea on the amount of chlorine normally found is quite striking, as the results of the estimations show. The observations show that at the sea coast the chlorine content is high, while as we travel inland there is a gradual decrease in the amount of chlorine normally found, this decrease being more rapid travelling inland from the Atlantic Coast than it is travelling inland from the Bay of Fundy shores.

Use of Isochlor Determinations. The judgment passed by the chemical analyst upon waters which are to be used for drinking purposes is based partly upon the amount of chlorine found in it, hence the object of determining isochlors is to give the analyst information as to the amount of chlorine normally found in water of known purity taken from the locality from which the sample under examination was obtained. Any excess over this amount would probably be due to influences other than that of minerals or of the

ocean; that is to say, due to pollution. The correctness of his judgment, therefore, would depend upon an accurate knowledge of this amount. For example: a potable water showing a chlorine content of 16 parts per million, coming from a region where the normal chlorine content was three parts per million, would be subject to suspicion; while coming from a region where the normal chlorine content was 12, it would probably be perfectly wholesome, as far as the analyst could judge from this determination alone.

Method of Procedure in Analysis. The estimation of chlorine in drinking water depends upon the titration of the chlorine with standardized silver nitrate solution, using potassium chromate as an indicator; the theory being that the chloride ion will be removed from the solution by the silver ion before the chromate ion is attacked. When all the chloride ion has been removed, the reddish color of the insoluble silver chromate appears, this forming a most delicate end point.

The silver nitrate solution is so made that one cubic centimeter contains sufficient silver to combine with one milligram of chlorine. Silver nitrate is carefully dried at 100 degrees in the oven, and an amount slightly exceeding 4.7937 grams is weighed out; this is dissolved in water, and the solution is made up to one liter in a flask which has previously been standardized and its error corrected. This solution was carefully mixed. In order to standardize this solution, potassium chloride was re-crystalized from a sample of known purity (Merck's guaranteed). The fine crystals thus obtained were carefully dried to a constant weight in the oven, and exactly 2.1065 grams were weighed out, dissolved in distilled water and made up to one liter in the standardized flask. This solution thus contained one milligram of chlorine per cubic centimeter. The silver solution was standardized by titrating from two to three cubic centimeters of potassium chloride solution, using

potassium chromate as an indicator, and determining the end point by comparing the color of the solution under examination with one clouded by a previous precipitation of approximately the same amount of silver chloride as would be obtained in the titration. This artifice was used throughout the experimental work. It was found that a definite amount of silver nitrate solution was necessary in order that pure distilled water, colored with potassium chromate should give the distinct color which served as an end point. This amount was determined by numerous experiments to be 0.09 cubic centimeters, and this amount was subtracted from the amount of silver nitrate solution necessary to give the end point reaction during the standardization experiments. In the standardization made a year later, this number was found to be .04 cc. By this means the ratio between the silver nitrate solution and potassium chloride solution was obtained, and the necessary dilution of the silver nitrate calculated. Thus the volume of the solution containing the excess amount of silver nitrate could be determined and removed, and the solution again made up.

Standardization Data.

The average of four accurate determinations of the ratio between the chlorine and silver solution gave:—

$$\text{Chlorine} : \text{Silver} :: .9565 : 1$$

Hence, the amount silver contained : proper amount :: 1 : .9565

1 mg. chlorine is equivalent to $\frac{107.93}{35.45} = 3.045$ mg. silver

$$X : .003045 :: 1 : .9565$$

$$\therefore X = .003183$$

which is the actual amount of silver in 1 cc. solution. But, 1000cc. should contain 3.045 mg. silver;

$\therefore \frac{1000 \times 3.045}{3.183} = 957.0$ cc. solution contain the pro-

per amount of silver. Hence it is necessary to remove 43 cc. from the solution and dilute to the mark with water. The ratio between the chlorine and the silver solutions was then found as follows:—

Chlorine	*Silver*
4.21	5.06
6.21	7.16
2.00	2.10 — .09 = 2.01
6.21	7.24
8.21	9.33
2.00	2.09 — .09 = 2.00

∴ 2.00 cc. chlorine solution = 2.00 cc. silver solution.

After a year of use the solution was again standardized, with the following results:—

Chlorine	*Silver*
4.79	5.28
6.86	7.42
2.07	2.14 — .04 = 2.10
Ratio 1.014	
.82	.93
2.85	2.96
2.03	2.03 = .04 = 1.99
Ratio = .9804	
2.84	2.99
5.04	5.18
2.20	2.19 = .04 = 2.15
Ratio = .9772	
Average Ratio = .9906	

It is observed from the above that one cubic centimeter of the silver nitrate solution will precipitate one milligram of chlorine; hence the number of cubic centimeters of silver

nitrate solution used in titrating 100 cc. sample of water multiplied by ten will give the number of parts of chlorine per million parts of water in the sample.

The indicator solution was prepared by weighing two grams of chemically pure potassium chromate dissolved in 100 cubic centimeters of water and adding silver nitrate until a permanent red precipitate is formed—the filtrate would thus be chloride free. One or two cubic centimeters of this indicator solution were used, depending upon the color of the water under examination.

The experimental method used in determining the chlorine content of a sample of water was to measure 100 cc. of water into a procelain casserole and color it with one cubic centimeter of the indicator solution. This was then titrated until a faint difference in color was observed between the sample and another one similarly prepared, which was placed beside it. By this means a very sharp endpoint was easily attained. The 100 cc. graduate was used in measuring the samples, as it was found impracticable to carry a 100 cc. pipette. In some cases difficulty was experienced in getting a sharp endpoint, owing to the water being discolored by peat, but by the use of the clouded control only in two or three instances was the error greater than .03 cc. of solution, that is, .3 parts per million.

The work of obtaining the samples of water necessitated covering large stretches of country; the work was of necessity done slowly, at different seasons of the year, and under different conditions of drought and freshet, making strict comparisons between the results obtained difficult. With a few exceptions the samples were collected by the writer, with the observance of every precaution, and all the analytical work was carried out by him. No use could be made of data derived from Governmental Reports, since water analyzed in public laboratories would probably be taken from doubtful or suspected sources. The work was done

either in the laboratory of Bloomfield High School, or in a small laboratory fitted up for the purpose at the writer's home, but in all cases the utmost precautions were observed as regards lighting and to guard against any chlorine introduced by improperly cleansed apparatus. The same silver nitrate solution which was prepared in the laboratory at Dalhousie University was used throughout the work, and was kept carefully protected from light and pollution.

No data was accepted without being carefully checked by two, and in most cases three, separate determinations of each sample. Wherever possible a number of samples were collected from a small area, and the lowest of these taken as the normal for that vicinity. The burette used in the titration was one containing 10 cc. of the solution, ringed around, and read by means of a lens. Great care was exercised in keeping this burette in perfect condition during the analytical work. The use of a graduate in measuring out the samples for analysis was necessitated, as above mentioned, by the inconvenience of carrying about a 100 cc. pipette, and it is believed that the error in reading this is well below the experimental error in reading the burette. In draining this graduate into the porcelain casserole a definite time interval was always allowed to elapse, and as far as possible all observations were made under identical conditions, so far as light was concerned, so that the experimental results at least would be strictly comparable.

The determination of the exact endpoint in white porcelain dishes was found to be somewhat easier than in the ordinarily used 100 cc. Nessler Jars. When dealing with water discoloured with peat, use was at times made of a drop or two of the chloride solution, to make sure that the endpoint had been attained, although, as mentioned above, in every case the standard of comparison was an identically prepared sample, and in cases where the chlorine content was high, and the cloud of precipitated chlorine rendered comparison

difficult, the control was itself clouded by titrating it nearly to the endpoint, and using this as a standard of comparison.

For the purpose of collecting samples, a number of new ten and sixteen ounce bottles were provided and fitted with new corks. These bottles were invariably rinsed three times with the water being collected before being finally filled, and these bottles were used for no other purpose save collecting water samples.

Wherever possible samples were taken from small brooks, usually at a distance of some forty to fifty yards from the road, and from a portion of the brook where the water was running freely. The greatest care was observed to avoid, as far as possible, portions of the brook used by animals, and when a brook ran through a meadow, it was followed up to the woodlands, where running water was obtained.

It was noticed that a large lake, which has no obvious source of pollution, shows a chlorine content as low, or lower, than small brooks running into it. In other words, a large lake gives a normal chlorine for that vicinity. For example, the northern arm of Lake George, in Yarmouth County, has a chlorine content of 10.0 parts per million, while a small brook discharging into the lake gave a chlorine content of 10.2 parts per million. Milton Ponds in Yarmouth County, in June, 1914, gave 13.0 parts per million, while several brooks running into the ponds ranged from 15 to 20 parts per million. In explanation it might be said that Milton Ponds are surrounded by farms. Grand Lake, in Halifax County, showed 4.1 parts per million, and as it was found impossible to obtain a sample from a brook discharging into Grand Lake, it was thought reasonable to assume that 4.1 was the normal for that vicinity.

This observation was later confirmed by noticing that the United States Geological Survey in the examination of waters in New England, frequently made use of determinations

of chlorine in reservoirs, lakes serving as town and city water supply, ponds, etc. (See U. S. Geological Survey, "The Normal Distribution of Chlorine", by Daniel W. Jackson, Water Supply and Irrigation Paper, No. 144.)

A number of determinations of well water, even under the most ideal conditions, showed that little confidence could be placed in results obtained from them.

Ideal conditions for normal chlorine content were considered to be a clear running brook, having its course through woodland, where there was no probability of pollution by cattle or sheep, and as far as possible from farms or dwellings. A few samples taken from brooks running through cleared land or pastures, with farms on all sides, were clearly polluted.

Localities Investigated.

A series of observations were made along lines running from the sea coast as far inland as possible. In this way six distinct series of samples were collected:—

One. A series from Halifax, Rockingham, Bedford, and Grand Lake to Truro.

Two. A series from Margaretville to Middleton, and thence along the line of the Halifax and South Western to New Germany and Bridgewater.

Three. A series from Yarmouth inland some thirty miles to Kemptville.

Four. A few observations in Musquodoboit Harbour and the Musquodoboits.

Five. A series taken from Pictou to Sherbrooke from samples collected by Dr. Mackay.

Six. A few samples in the extreme eastern end of the Province, Antigonish, Port Mulgrave, etc.

It will be noticed that these lines are at right angles to the seaboard. The second and fifth series stretch across the Province.

Series One. Several samples in the vicinity of Halifax, Melville Cove, Fairview, Rockingham and Bedford ran from 6.5 to 4.8; Grand Lake 4.1, Truro 4.9, showed a decrease to a minimum and then an increase. An observation of 4.4 at Middle Musquodoboit closely corresponded to these.

Series Two. At Margaretville a small brook running over the cliff into the Bay of Fundy showed 33; another a mile back over the mountain, 8.5. A small brook on the top of the mountain, under ideal conditions, gave 10.1, while a brook at Spa Springs showed 9.8. These observations, although showing an increase on the line over the mountain, are checked by an observation from a small spring by the roadside of 10.4, and the Spa Springs brook itself, 11.5. Middleton tap water, derived from a lake on the South Mountain, somewhere near Nictaux, showed 6.6, Alpena 6.7, Lake Pleasant at Springfield, 4.6 (sample taken from lake), New Germany 3.8 (the lowest of the three observations, the others being 4.3 and 4.4), Northfield 4.3, WestNorthfield 5.0, Bridgewater 5.4. A brook six miles below Bridgewater running into the salt estuary of the LaHave 7.5, completes the series. This series shows a distinct decrease to a minimum at New Germany and a clearly defined increase from New Germany to the mouth of the LaHave.

Series Three. A number of observations in the vicinity of Yarmouth, ranging from 65 in a sample taken from at well in a narrow sand spit between the Bay of Fundy and Yarmouth Harbor to 21.5 in a well near Yarmouth Harbour, under ideal conditions, and numerous observations of 16 and 17 taken at various points within a few miles of the town, show very clearly the influence of the salt water and salt water estuaries in that vicinity. Two series of observations were made; one covering a small section of country from the northern part, Lake George to Lake Annis (three or four miles) another over a twenty mile stretch from Deerfield to Kemptville. Lake Annis showed 10.0 and Deerfield 10.2,

and as these two points are equi-distant from salt water, a clearly defined line (the ten normal) can here be drawn. Carleton showed 8.4, and a brook a little further up 8.2. A brook just below Kemptville 7.0, and a large stream above Kemptville, 28 miles from Yarmouth, 5.1.

This series shows a continuous decrease, running from the coast line inland, and it is noticed that the observation of 5.1 near Kemptville, is about the same distance from the salt water as the observation 5.0 at West Northfield (Series 2).

With reference to the high chlorine content of wells and brooks near Yarmouth, the prevailing winds are to some extent responsible, for during heavy, south westerly gales, windows in the lower parts of the town of Yarmouth are sometimes covered with an encrustation of salt carried evidently in spray from the breakers on the rocky coast, fully two miles away.

Series Four. This consists of only three or four observations, one of a sample taken from a well at Musquodoboit Harbor, which showed 4.6, and a few observations in the vicinity of Middle Musquodoboit; the lowest being 4.4 from a brook running about two miles above the river.

Series Five. At the mouth of Pictou Harbor a brook gave 10.4, two or three brooks south of New Glasgow 4.6 and 4.1; brooks at Kerrogare and eastward 5.1, 5.3 and 5.4. Melrose Lake 5.1 and Sherbrooke Lake 7.0, again showing the decrease and increase.

Series Six. A brook supplying the reservoir at Antigonish gave 6.8, defining an important corner of the seven normal. A brook at Port Mulgrave gave 8.2, locating the ten normal practically on the Strait of Canso shore. A brook near Philip's Harbor gave over 15, a value recalling those obtained near Yarmouth at the other end of the Province.

The Ten Normal.

The location of the ten normal line in Yarmouth County is clearly defined by the observations at Lake Annis and Deerfield. By drawing a line roughly parallel to the coast line of the Bay of Fundy, it is found to pass well inside of Annapolis Basin, up through the Annapolis Valley—its location being defined at Spa Springs and passing somewhere north of Canning. Around the southern shore this normal may be drawn in the same way, following the coast line, passing north of Shelburne, crossing the LaHave River at a point about five miles from its mouth and appearing at Halifax, probably near Herring Cove, and from there east quite close to the Atlantic Coast. Still further east it lies well outside Sherbrooke, cuts across the head of Chedabucto Bay, is located at Port Mulgrave, passes north of Antigonish and through Pictou Harbor.

The Seven Normal.

Starting from a point south west of Kemptville in Yarmouth County, the seven normal line runs parallel to the ten normal, about seven miles from it, and gradually increasing this distance to about ten miles, according to the observation at Alpena, and running about three miles north of Kentville and along the south shore of Minas Basin. Running south from Yarmouth County the seven normal apparently is only four or five miles from the ten normal, and passes through Bridgewater, appearing at Halifax a little south of Melville Cove, thence easterly, but still south of Musquodoboit Harbor. It passes through Sherbrooke and follows the trend of the ten normal, passing just north of Antigonish and through Pictou.

The Five Normal.

Starting at a point above Kemptville, about four miles from the seven normal, running northerly, crossing the Halifax and South Western Railway at Dalhousie, at which

point it is about eleven miles from the seven normal. It runs a few miles south of Windsor, and thence nearly to the head of Cobequid Bay, its distance from the seven normal gradually increasing. Around the Southern shore it apparently runs from six to seven miles from the seven normal, crossing the same railway at West Northfield, cutting across Bedford Basin between Rockingham and Bedford, and appearing somewhere south of Musquodoboit Harbor, at which point it is only about two miles from the seven normal. It turns north through Guysboro County and is well located by several observations in eastern Pictou County, passes north of New Glasgow and joins the branch passing just north of Truro.

The Four Normal.

Conforming to the normals already drawn in the Western part of the Province, the four normal apparently forms a closed curve, crossing the Halifax and South Western Railway just south of Springfield, and again south of New Germany; crossing a part of the Province in which many large lakes, such as Lake Rossignol, are situated. Another limb of the curve probably passes through Grand Lake. and also somewhere about ten miles east of Truro, and curves back just south of Ferrona, uniting with the line passing north of Middle Musquodoboit as the normal at Musquodoboit was 4.4. This indicates that the larger portion of Halifax County lies between the four and five normal and only in a narrow strip of country might chlorine contents of less than four be expected.

Isochlor Work in Other Places.

Isochlor maps of the New England States and of New York have been prepared and are given in the U. S. Geological Survey paper, already cited. Those of Massachusetts and Connecticut are given in "Examination of Water", by Dr. W. P. Mason. A comparison of these maps with that given

herewith shows that high normal chlorine does not occur as close to the sea coast in those States as is the case in Nova Scotia. The Cape Cod Peninsula, as might be expected, shows rather high observations, ranging from ten to twenty-five parts per million, and these values are comparable to those found in the vicinity of Yarmouth, Nova Scotia, which is also more or less surrounded with salt water. These maps, which are based upon an enormous number of observations throughout the States, are necessarily much more complete than that of Nova Scotia.

It will be noticed that no observations from the extreme eastern part of the Province have been included. This is owing to the difficulties and expense involved of personally obtaining samples in Cape Breton. No samples were collected in northern Colchester and Cumberland County for the same reason.

One other line along which the research was prosecuted deserves notice. In the paper of the U. S. Geological Survey already cited, tables are included giving monthly observations of numerous sources. An attempt to verify the result noted there was made in a very small way. Monthly observations were taken from two brooks with the object of discovering any great seasonal variation. Only one of the two, as will be noted from the appended table, is very satisfactory; this shows a fair degree of constancy over the time that the observations extended, that is to say, the seasonal variation is very slight.

In conclusion, I have to thank the kind offices of many friends who made it possible for me to collect samples in what would have been, without their help, inaccessible places, and also for information regarding the location and sources of streams. In particular, I have to thank Dr. Mackay of Dalhousie University for not only proposing the work, but for collecting samples which made it possible to draw the isochlors over the eastern part of the Province.

A table giving the observations which were of the greatest value in determining the position of the isochlors is appended, together with a map upon which the position of these observations is indicated as closely as possible.

Sample No.	LOCATION	Chlorine Content	No. Analysis in Notebook
1.	Purcell's Cove	9.5	92
2.	Brook Dutch Village	5.1	48
3.	Brook Dutch Village	5.8	3
4.	Giezer Hill	5.5	49
5.	Melville Cove	6.5	51
6.	Rockingham	5.4	50
7.	Moir's Mill, Bedford	4.8	52
8.	Sackville River, Bedford	4.3	53
9.	Grand Lake	4.1	57
10.	Brook Lake Thomas	4.8	63
11.	Truro Park	4.9	58
12.	Musquodoboit Harbor	4.6	54
13.	Middle Musquodoboit	4.4	56
14.	Coldbrook	6.4	91
15.	Two miles north Coldbrook	6.4	90
16.	One mile south Wolfville	6.8	89
17.	Margaretsville Cliff	33.7	46
18.	One mile south Margaretville	8.3	45
19.	Three miles south Margaretville	10.1	44
20.	Spa Springs	9.8	41
21.	Middleton tap water	6.6	47
22.	Alpena	6.7	1
13.	Springfield (Annapolis)	4.6	2
24.	New Germany	3.8	5
25.	Wentzell's Lake (brook)	4.3	10
26.	Northfield	5.0	9
27.	Three miles north Bridgewater	5.5	7
28.	One mile north Bridgewater	5.4	6
29.	One mile south Bridgewater	7.1	11
30.	Six miles south Bridgewater	7.5	12
31.	Brooklyn, Yarmouth County	15.9	16
32.	West Brooklyn, Yarmouth Co	17.3	39
33.	Lakeside Park, Yarmouth	16.3	17
34.	Well near No. 33	16.7	19
35.	Well, Overton, Yarmouth	21.5	21
36.	Well Yarmouth Bar	65.0	22

37.	Lake Annis Brook	10.2	24
38.	Lake Jessie Brook	10.2	23
39.	Lake George, East shore	11.7	25
40.	Brook discharging near No. 39	11.5	26
41.	Lake Annis	10.0	27
42.	Ohio	17.4	28
43.	North Ohio	13.2	29
44.	Deerfield, brook	9.7	30
45.	One mile south of Carleton	8.4	32
46.	Two miles north of Carleton	8.2	33
47.	Four miles north of Carleton	7.0	37
48.	Kemptville River	5.1	35
49.	Mountain Rill, Pictou County	4.6	60
50.	Forbes Lake	4.1	61
51.	Simms Anderson Brook, Pictou Harbor	10.4	62
52.	Four miles north of Sunnybrae	5.2	75
53.	Kerrogare	5.1	76
54.	Eden Lake	5.3	77
55.	Neil Grimms Brook	5.4	78
56.	Sherbrooke Lake	7.0	79
57.	Melrose Lake	5.1	80
58.	Salmon River Lake, Halifax County	5.8	81
59.	Giant Lake	6.0	84
60.	Hurlbert Brook, Lochaber	5.4	85
61.	Brook at Reservoir, Antigonish	6.8	86
62.	Port Mulgrave	8.2	87

Sample 9 collected by Miss Nora Piers.
Sample 11 collected by Mr. E. Chesley Allen.
Samples 49-61 collected by Dr. E. Mackay.
Sample 62 collected by Miss Grace M. Huestis.

MONTHLY OBSERVATIONS.

Month 1917	Fenerty's Brook	Melville Cove Brook
March	7.5	11.3
April	6.7	8.7
May	7.0	9.2
June	7.2	8.7
July	7.7	9.2
August	7.9	8.4
September	8.0	8.7
October	...	9.2
November	7.9	9.4
Average	7.5	9.2

On the Nature and Origin of the Eskers of Nova Scotia.—By Walter H. Prest, Halifax,. N. S.

Introduction.—My attention has been drawn to the lack of scientific work done on the eskers and other glacial deposits of Nova Scotia. Having given some time to the distribution and history of our glacial deposits, I should like to consider their origin and offer a few suggestions as to future and more critical examinations than I have had time to make. For years I have subscribed to the generally accepted opinion that eskers, as these ridges of sand and gravel are called, belong to the sub-glacial drainage system of the latest phase of the glacial age; but a more recent comparison of facts has convinced me that no such explanation could possibly account for conditions as they are now.

A New Theory of Origin.—I know that in advancing the theory of origin given below I am in complete opposition to some scientists of the highest reputation, but I trust the evidence I offer will carry weight enough to at least deserve consideration.

As some of the members of our Institute may not have bestowed much time on the glacial geology of Nova Scotia, I shall explain what an esker is. I will use the more familiar name of *esker*, rather than the Swedish name of *osar*, often used by American geologists.

What an Esker Is.—The esker is a narrow ridge of stratified sand and gravel with occasional boulders. These ridges with small interruptions often extend for many miles, resembling in some places a well-built highway or railway embankment. The *kame* is also composed of the same material as the esker but resembles a mound rather than an embankment. The kame properly belongs to a system of modified drift; but the esker has a system of kames altogether separate from the kames formed by other aqueous and erosive agencies. These are known locally as horse-backs, hogs-backs, turnpikes, Indian roads, etc. Kames are very common, while eskers are very rare.

The Eskers of Nova Scotia.—The number of eskers in western Nova Scotia is quite considerable, but may be lessened by exploration, when detached sections will probably be found to be only portions of longer eskers. Some of these attain a perfection of form not excelled elsewhere. The majority of these run across the drainage system of the province. The longest and most prominent eskers run across the highlands of the interior, crossing minor elevations and depressions on the way. The shorter ones are usually found where a plateau breaks off into a sloping surface, or where a valley bounded by high hills runs either across or parallel to the course of ice movement.

The Great Central Esker.—The longest esker in Nova Scotia is one that runs with few interruptions from south-west of Hectanooga in Digby County, north-easterly towards the source of Bear River. This is said by hunters to be the same one that runs from the source of Bear River easterly to the western side of Kejimkujik in south-western Annapolis County. It crosses the valleys and watersheds of all the streams running south into Yarmouth County and north into Digby County. It borders on or crosses lakes as broken gravel ridges instead of being spread out as deltas or flood plains, as we have been taught that they

should be. On an elevated plateau south of Wentworth Lake it is broken up and meanders in a curious way completely independent of water-sheds, drainage slopes, and streams. Futher west at the foot of a lake at Hectanooga it reaches its greatest development; sixty or seventy feet high it dams back a lake, and along its crest is built a highway. South west of this I did not trace it, but it is said to extend nearly to the sea-shore. Its eastern extension crosses some of the highest land in the western part of the province near the head-waters of the Liverpool, Tusket, Sissiboo, and Bear Rivers, where it is often 30 to 50 feet high. Its height and regularity makes it one of the most noteworthy natural features in the province. Its total length must be 60 or 70 miles. The eastern end of this esker is seen crossing the watershed and descending easterly to the Liverpool River at Kejimkujik. A more northern branch of it crosses the lake called the Frozen Ocean by a string of islands and gravel banks. Advancing up the next slope it crosses to Annapolis-Liverpool road north of Maitland. From thence it goes eastward, and 25 or 30 miles east of this a like ridge crosses the Nova Scotia Central Railway on or near the same latitude.

West Brook Esker.—A short ridge crosses the West Brook of the Liverpool River at the point where the higher level lands break off into the slope that descends to the river. Like may others, it marks a change in the angle of descent.

Middlefield Esker.—To the east of this and on the same course, a well developed ridge crosses the Annapolis-Liverpool road at Middlefield. This may possibly be the extension of the West Brook esker. It is a well defined ridge of gravel, rising and descending with the slope of the land on the watershed across which it runs. Like most of the others it crosses the general course of drainage as well as the direction of the glacial movement.

Another in the Blue Mountain region of Northern Shelburne crosses the drainage system near Roseway Lake.

Gold River Esker.—A short esker flanked by well defined kames is seen on the West side of Gold River. It marks the junction of a slope with a tract of flat land above. It runs North and South parallel with Gold River, while the local drainage and ice movement in the last stage of the ice age was East toward the river.

Stewiacke Esker.—In the eastern part of the Province we find one of a moderate length and height on the north side of the Stewiacke River a few miles above Lower Stewiacke Station.

Nine-Mile River Esker.—The most conveniently situated esker for study is at Nine-Mile River in Hants County. It runs north-westerly, beginning nct far from Enfield Station, and crossing the river, runs with varying course and height for ten or fifteen miles. Another prominent, but short gravel ridge runs east and west in the valley of the Five Mile River on the Midland Railway in Hants County.

Two well defined eskers run down the valleys of the Hebert River in Cumberland County, and the Clyde River in Shelburne County. The first is about eight miles long and ten to fifteen feet high. The latter is also a large esker several miles long. The Hebert River esker begins at the foot of the Cobequid Mountains near Halfway Lake, and runs north along the west side of the river. While the south end is about fifteen or twenty feet above the river, the north end is forty to fifty feet above it, and the top is nearly level. The north end is about one hundred and ten feet above high tide in the Bay of Fundy. Branches become parallel to the main esker or sweep around hollows, enclosing bogs. The top is often only wide enough for a wagon. The ridge contains large well worn boulders. Another esker near Thos. Leadbetter's, Upper Barney's River, is ten to eighteen

feet high, with a narrow top. Near Round Lake, Guysboro County, is one about fifteen feet high and a half mile long; it is very narrow and runs north-east. An interesting esker is said to run North from the Northern boundary of Pictou Town, across Acadia Farm and into the woods beyond. A good section of it was made by the highway near its origin.

Other eskers exist in the Province, but quoting from memory, the above are all I can recall just now.

Cross Drainage System.—The most noticeable feature of these eskers is the fact that the most of them cross the present drainage system of the country. Few of them run parallel with the main streams.

Eskers of Maine.—Turning to the eskers of the United States, those of Maine are most worthy of notice. Mr. George Stone, in Monograph XXXIV of the U. S. Geological Survey, has reviewed the work of other geologists on this subject. Because of this review, his conclusions on the eskers of Maine are examined below.

Cross Drainage System.—These eskers, like our own, meander over hill, valley, and plain alike. They often pass from one valley to the valley of another stream, crossing a divide from 200 to 400 feet high. In level or swampy land they form natural roadways, and have been used as such. Quoting him, we read: "These great embankments reaching from 20 to 140 miles, cross rivers, valleys, plains and hills, skirting hill-sides far above the valleys, meandering across plains where no obstructions exist to cause it to meander." They are very variable in height and breadth, a narrow ridge a few feet wide being succeeded by a portion of the same ridge 100 to 200 feet wide. As in Nova Scotia, they often divide and re-unite, are interrupted, or spread out into lines of mounds.

Gaps.—There are many gaps in the Maine eskers; these are usually less than half a mile in width, but rarely two miles. The Nova Scotian eskers also have gaps, which as a rule are very short.

The Maine eskers, according to Stone, run south-west to south by east, coinciding in some places with the course of the drainage and ice movement, though not enough to suggest a controlling influence.

It will be noted that though these eskers do not always coincide with the local elevations and depressions, they agree in course with the central watershed and the general slope of the country toward the sea.

Tributaries and Deltas.—Stone also says that one esker has a tributary system at the north end and a delta system at the scuth end. I do not know how far this is self evident. I have never seen an instance of either in Nova Scotia. The nearest approach to it is on the top of a high open barren south of Wentworth Lake in southern Digby County, N. S., east of Hectanooga. This is certainly an unusual place for a delta, being nearly 20 miles from the end of the esker. In this province the eskers cross lowlands, swamps and lakes, as ridges, strings of islands, or gravel banks, without much evidence of the spread of their contents.

Stratification.—Both eskers and kames are stratified in a very complex manner, the eskers often more complex than the kames. Both transverse and longitudinal sections show cross bedding. Sometimes the bedding has been twisted into almost vertical positions, the result of distortion since deposition. Some eskers consist of water worn pebbles and gravel out of which the fine stuff had been washed. In others the lines of stratification are said to have been obliterated, though I suspect that stratification has never taken place owing to scarcity of water. However, owing to lack of investigation, no definite opinion can be given on this point.

Crossing into the Province of New Brunswick we find a like system of eskers there. In the western and central parts of that province the glacial striæ runs from south to south 65 degrees east, inclining to the east and north-east as they approcah the gulf of St. Lawrence. Some of the eskers cross into the state of Maine, especially one on Eel River. Others are located at Canterbury and Queensbury, York County, and Wakefield, Carleton County; still others are seen along Deadwater Brook, Fish Creek, and the mouth of Nacawicac River. The courses are generally south-east. Whether these agree with the course of the local watersheds and valleys, I do not know. They also are among the points needing investigation.

In Nova Scotia, while the shorter eskers agree in course with the local elevations and depressions, the most important ones run lengthwise through the province on or parallel with the central watershed.

Origin of Eskers.—Regarding the origin of eskers, Mr. Stone says on page 40, "When one sees gravel systems going up the northern side of a hill 200 feet or more in height, it seems that a stream could flow southward over such barriers. That they actually flowed over such barriers is strong evidence of the existence of ice." Here I would ask why such inferences are assumed as facts in order to support theories so contrary to other evidence. The pressure and head of water needed to drive water with its load of gravel and rocks up and over such hills could only be secured in water-tight channels beneath or within the ice. Any leakage would lessen the power of the water to drive the debris forward.

Subglacial Tunnels.—Now this theory of subglacial tunnels is based on the assumption that the water and gravel actually ascended over 200 feet and in south-western Maine 400 feet. This would mean a pressure of 81 to 162 pounds per square inch—sufficient force to drive water through the interstices of any subglacial debris or to project a huge torrent with the

force of a giant pump. But where the head and power for such a siphon tube is from fifty to one hundred and forty miles away from the watershed over which the debris is to be lifted, the chances for a perfectly tight tube of that length are exceedingly slender. Such phenomena have never been seen.

Impossible Theories.—I think the evidence justifies one in saying that siphon-like action by subglacial streams on such a large scale is absolutely impossible. I will consider further objections to this theory later on.

Superglacial Streams.—The theory of superglacial streams as a source of esker formation is also untenable because Nansen and other explorers say that glaciers or smooth or slightly undulating slopes carry no debris on their surface, as to those glaciers lying among projecting mountains According to Nansen, Peary, Nordenskjold, Shackleton, Amunsden and other explorers, neither Greenland nor the Antarctic continent show any support for the theory of the formation of eskers by either subglacial or superglacial streams.

Confused Theories.—To show the confusion and uncertainty attending past investigations into the origin of eskers, I will give several quotations showing the indefinite and contradictory theories so far advanced. On page 422 Stone says: "The conclusion is that the great length of the eskers of Maine favors the hypothesis that they were mainly formed in subglacial tunnels", yet on page 426 he says, "So far the probabilities favor the theory of superficial streams."

On page 363 both theories are reduced to impotence when we read this: "We naturally wonder whence the gravel-moving waters came and whither they went and what became of the finer material they carried with them". So the mystery deepens, and deeper mystery follows when we ask where

these great streams emptied after ascending the 400 foot hills of south-western Maine, and after a flow of over 100 miles. No wide estuary is seen there. They simply disappear.

Further on Stone says: "Probably all the field phenomena may be accounted for by either hypothesis, but by such cumbrous complications that in the end must break down any hypothesis". Of extremely narrow eskers changing to wide, high eskers, he says: "That rivers capable of transporting so great a quantity of sediment should occupy such narrow channels is truly wonderful". To this we all agree.

Deflections.—Regarding deflections in the course of eskers, many supporters of the subglacial theory cannot account for their leaving a valley to cross a watershed or to cross the course of the ice movement. Other deflections on level plains without any streams or obstacles to cause the deflection, are just as unaccountable when ascribed to the subglacial theory.

After considering a great many varied theories of origin, we read on page 426: "The long meanderings transverse to the ice-flow certainly add some difficulties to the hypothesis of subglacial streams". Under the subglacial or superglacial theory the following is unexplainable: At Leighton Brook, a few miles south-east of Aurora, Maine, is seen a ridge of boulders parallel with the ice flow. Across this at right angles is a well defined esker ridge—neither interferes with the other. Here we possibly have a subglacial stream crossing an esker without disturbance but the formation of the esker must have been due to some other cause.

Confusion of Theories.—The uncertainties attending these theories are well shown in page 430, where we read: "No positive inferences can as yet be drawn from the observed facts bearing on the question of subglacial versus superglacial streams, though probabilities favor superglacial streams." Page 323 gives us the following: "The general inference is that the courses of the great glacial rivers were determined

to the passes before the eskers were deposited, or the hills bare of ice". Here Mr. Stone comes perilously near the true theory of esker formation, which he makes more probable on page 363. Here he says: "The fact that we find a gravel ridge without a delta in a place so favorable for the formation of a delta indicates that the ridge was deposited within ice walls before the ridge had retired as far north as the esker".

Subglacial Streams.—He presents evidence that calls for a totally different theory of origin and yet refuses to grasp it, for on page 426 he says: "For the subglacial waters to flow transversely to the motion of the ice must have been the exception rather than the rule".

Indefinite Theories.—This uncertainty is voiced by many authors, who, after considering the evidence for the different theories, have been unable to come to any decision. One investigator says: "It might happen that the same esker river was in different parts of its course, subglacial, englacial and superglacial". Another hopeless sentence is: "So complex is the problem that it cannot be claimed that all the elements have been set forth".

Thus there is little hope of a satisfactory solution to the mystery of the origin of eskers among such indefinite theories.

Such appears to be the general opinion of our foremost geologists, among whom are Chamberlain and Salisbury. Their Geology, Vol. VIII, is also a review, and indefinite conclusions abound in it.

Tremendous Velocity of Subglacial Streams.—Speaking of eskers they say: "Subglacial streams seem sometimes to have deposited gravel and sand in their channels". With commendable caution they say: "It is not to be inferred that eskers never originated in other ways, but it seems clear that this is one method and perhaps the principal one by which they came into existence". And again: "Long eskers sometimes wind up and down over low elevations and valleys,

showing that the water which made them must have been under great head if they are of strictly subglacial origin". To prove the tremendous velocity of these subglacial streams some authors point to the so-called fact that the debris in these streams have been transported up and over high hills. Why this insistence on such facts, as they are called, when none have been proved? And how could water raise itself higher than its source? Some contest this with the theory that there has been an unequal elevation of land in this part of the state of Maine since the formation of these eskers. The known evidence, however, proves that there has been an equal amount of post glacial elevation all along the coast of Maine. It needs a very unequal amount of elevation to form new lines of drainage.

Eskers Cross Drainage.—The fact that these eskers do not coincide with the natural course of drainage shows that they were not formed by the sub-glacial drainage system. The gravel ridges in Nova Scotia also often run across both the course of drainage and glacial movement so that any motion in these ridges must have been at right angles to their course, that is down hill.

While most of the eskers of Nova Scotia and Maine cross the glacial striæ and the drainage system, the kames are nearly always parallel with the course of ice movement and the drumlins or hills of unstratified drift are always so; therefore we cannot possibly ascribe all to the same cause.

Tributaries.—Subglacial streams, naturally following the course of the drainage, would without doubt be joined by other subglacial streams; therefore the resulting esker would necessarily have tributary eskers. The facts are that the course of eskers is not governed by the slope of the land in Nova Scotia any more than in Maine; and as far as my explorations go the eskers of Nova Scotia are not joined

by tributary eskers. The branch eskers of Nova Scotia with one exception, are parallel, re-uniting at a short distance. This exception divides going down a slope. The usually stratified condition of these eskers show the action of running water, but to what extent their formation is due to this remains to be investigated, but we know that the presence in the eskers of Nova Scotia of fine sand and sometimes clay shows usual deposition by a moderate current.

Course of Transportation.—Tranverse eskers do not always contain the same constituents as the surrounding till or modified drift. This is an important point, as it gives us valuable information as to the source of the material of the eskers. However, like many other points, it needs investigation to decide whether this material came along the course of the so-called esker stream, down the drainage system, or directly along the course of ice movement.

Eskers, as a rule, contain little clay, indicating a leakage of the fine material, even on the lowlands.

Chamberlain and Salisbury say that esker stratification is often much distorted, probably on account of ice pressure. Ice pressure could not possibly exist in a subglacial stream which was continually eroding its channel with an extremely rapid current heavily loaded with coarse sediment. These varied opinions show the need of further investigation.

Fatal Objections.—Another and more fatal objection to the subglacial origin of eskers is the following: We have been considering the subglacial stream as fully formed, and in continual operations as a huge siphon, but there was a time when there was no subglacial channel and the whole eastern part of the continent to the latitude of New York was wrapped in a mantle of ice. When we think of the first few drops of water trickling through the first tiny crack, or leaking beneath the ice, by what vagary of natural law can we conceive it defying the force of gravity and forcing a passage up hills 400 feet high and down across well-marked

lines of drainage as in Nova Scotia and Maine. To what natural phenomena can we turn to find a power that would drive a single drop of water over a watershed 200 to 440 feet high, and finally carry millions of tons of debris to the same height. What was the influence that guided the course of the first tiny crack directly across the line of drainage of Nova Scotia. If we admit the possibility of a transverse open crack we kill the siphon theory of subglacial action, as the crack must be filled 400 feet deep before running over a watershed of that height.

Another noteworthy fact is that on the plains or swamps or Maine many eskers are partly composed of sand. This indicates a moderate current. It needs a rapid current under tremendous pressure to drive large rocks over watersheds 200 to 400 feet high. This is also absolutely fatal to the subglacial theory of esker formation.

In view of these facts we are forced to admit the utter impossibility of accounting for the existence of eskers by any form of marine, fluvatile, or lacustrine agency.

New Theory of Esker Formation.—But there have been conditions under which the distorted stratification mentioned by Chamberlain and Salisbury was inevitable. In fact it could not be otherwise. This embodies a theory of formation of eskers different from any yet considered and will be detailed later.

Other Objections.—Eskers are irregular in size, height and character. Unlike rivers, eskers never increase regularly in size the further they go, except in river valleys. This fact furnishes one of the strongest clues to their origin. If eskers were formed in subglacial channels we would always find the smallest ridges near the surface of the streams and on high lands and the greatest spread of washed material on the plains. That this is not so is strong evidence that eskers were not

formed in, or subject to, the outflow of any stream, either of the open or subglacial kind. We would also find a common system of tributary eskers, which we do not find.

A resume of the special characteristics of the eskers of Nova Scotia is as follows:

1. The principal eskers in this province run lengthwise over the highest lands of the watershed. Other shorter ones run lengthwise along the principal valleys. Thus there are two sets, one transverse to, and the other parallel to, the drainage system.

2. The majority cross the main lines of drainage.

3. They also cross lakes, rivers, and minor elevations and depressions.

4. They cross also the course of ice movement.

5. They were laid over hill and valley alike without leaving any sign of an accompanying watercourse eroded into the surrounding drift, even where the slope is suitable.

6. The most characteristic and well defined eskers are on level or slighly undulating land. The largest, but not the longest eskers are in the river valleys.

7. Well defined ridges often cross low or level land and lakes without showing a kame or delta formation.

8. Eskers are sometimes interrupted by gaps, small kames and pot-holes.

9. Transverse eskers, as a rule, contain more foreign material than the surrounding unmodified drift.

10. Eskers contain little clay compared with the surrounding drift.

11. Eskers often descend or ascend a slope, cross low land and continue up the opposite slope with undiminished height.

12. Since their formation as ridges, transverse eskers appear to have been subject to less modification than any other form of glacial deposit, though their exposed position would seem to make them more liable to erosion than others.

13. Eskers in river valleys only show strong evidence of having become lines of drainage, until the total disappearance of the ice allowed the streams to follow their present course.

A Rare Phenomenon.—Most investigators have made the usual mistake of ascribing uncommon results such as eskers, to the most ordinary causes. They must necessarily be ascribed to uncommon causes, because of their striking difference from every other class of deposit.

Glacial Crevasses.—A perusal of the explorations of Peary and Nansen on the Greenland ice and Shackleton, Scott and Amundsen across the Antarctic continent shows that one of the most striking features of these ice-covered lands are the long deep transverse crevasses that obstructed their way. Nansen says that these crevasses were largest and most numerous in Greenland where the central plateau breaks off into slopes 7 or 8 miles from the east coast and 25 miles from the west coast. Nansen and Peary saw some crevasses 50 feet wide and on the Antarctic continent they were even wider. Nordenskjold also adds his testimony to this. So deep were some of these crevasses that they could not be sounded. So long were they that the ends were seldom seen. Shackleton mentions several from 10 to nearly 100 feet wide and mentions some down which he could see 300 feet. In others no bottom could be seen. Many of these great crevasses broke up into smaller ones which spread out and finally became untraceable. At least one of the long eskers of Maine exhibits this peculiarity. These deep snow-covered crevasses were veritable death traps. One black and apparently bottomless crevasse holds the last of Shackleton's ponies; others hold the bodies of many adventurous explorers, entombed in a sepulchre of ice. At another place was a belt of crevasses half a mile wide. This is probably a repetition of the tributary and delta systems

among the eskers of Maine, as well as those of Sweden. At one point on the Antarctic glacier were two huge parallel crevasses probably thousands of feet deep.

Valley Crevasses.—One peculiar crevasse noted by Shackleton was formed lengthwise in a valley near Mt. Nansen; unlike those on ridges, this crevasse was closed at the top but was located because of a range of ice cliffs along the valley. As it was formed through the downward sag of the ice sheet, it would probably be open at the bottom and become a receptacle for eroded debris. These valley crevasses may account for many of the eskers lying parallel with the rivers. These only may be termed subglacial channels until the increasing temperature dissolved the ice and opened the crevasse to the light of day.

Valley crevasses have been seldom seen in Arctic and Anarctic regions for plainly obvious reasons. An ice sheet crossing a ridge would crack open at the top; an ice sheet crossing a valley would crack open at the bottom and therefore be invisible. The one mentioned by Shackleton became known only because the ice on one side of the crack sank below that on the other side and left a row of ice cliffs 20 feet high.

Crevasses formed on watersheds may be forced down the next slope, but the tension being relieved, no more crevasses may form for some time on the same ridge. In Maine some eskers are seen on hillsides far above a river valley. Having evidently been formed on the ridge to the rear it had only time to move slightly in its ice-walled channel when the ice sheet melted. Not being in or near the bed of a stream the esker remained undisturbed.

Eskers in valleys, such as those near Hebert and Clyde Rivers in Nova Scotia, must be placed in a different class, owing to a distinct difference in level and position. The original cracks, coinciding as they do with the course of

drainage, and receiving the flow of water and sediment from above its level, the esker becomes in time an immense bank of water worn gravel, like those on the Ashuanippi and other rivers in Labrador. This condition would undoubtedly continue until the disappearance of the ice from the low lands allowed the sediment-charged waters to retire to their present beds. Thus all features of eskers are accounted for except those due to the most recent action of the present streams.

A. C. Lowe and others, in their explorations of Northern Canada, note the immense eskers of Labrador, especially one of 100 miles long, hundreds of feet wide and 40 to 60 feet high. The Hamilton, Ashuanippi and Dobuant Rivers are noted for their great valley eskers as well as other smaller but well developed ones on higher ground. Like all other valley eskers, they owe their birth and growth to a crevasse which formed when that part of Canada was still under the northern ice sheet.

Transverse Crevasses.—The larger visible crevasses of Arctic and Antarctic regions were formed across the course of ice movement, just as in Nova Scotia and most important eskers lie across the courses of both drainage and ice movement. What deposits these great crevasses actually contain will be unknown until a future interglacial age lays bare the earth probably 5,000 feet beneath the present surface. That they contain debris is both possible and probable, as we know that the edges of these crevasses have the same eroding power as the edge of the ice front. This, however, we cannot see.

The Crevasse Theory of the Origin of Eskers.—But this we know:

1. That the visible crevasses run across the course of ice movement as the majority of our eskers do.

2. That they cut across all minor undulations as our eskers do.

3. That the true drainage channels cut across and drain these crevasses, thus preventing them from becoming torrents as they would be if they were the *only* drainage channels. The same conditions probably prevailed in Nova Scotia where the streams cross the eskers.

4. Systems of diverging fissures, caused probably by the ice sheet passing over a hill or mountain spur, have been seen by Shackleton. Corresponding systems of diverging eskers have been seen in Maine and possibly in other countries.

5. Therefore we know that these crevasses are not a part of the permanent drainage system of Nova Scotia, Sweden or Eastern America.

6. That these transverse crevasses are being carried forward with all that is in them, with slow but invincible power, undoubtedly causing distorted stratification, and a mixed condition of the contents, such as we actually see in our own eskers, is evident.

7. If there is debris for the subglacial stream to gather up and transport there must be also debris for the transverse crevasse to gather and transport.

8. While the stream gathers debris only from its line of drainage, the crevasse would gather debris from the whole breadth of country behind it, hence the accumulations must be somewhat different in each. So too, is there a difference to some extent between the contents of the eskers and the valley kames of Nova Scotia.

9. As to the origin of the esker contents, Prof. Russell says that the lower 50 feet of the Malaspina glacier contains much earth, pebbles and other eroded material; the same is said of some of the Swiss glaciers.

10. Glaciers carrying debris at last come to a stand-still; and when melting the crevasses must leave their contents behind them in a comparatively undisturbed condition, altogether different from that of the stream gravels and other modified glacial deposits in the line of drainage, as is evident in Nova Scotia.

The evidence elsewhere is much the same as here. Nansen tells that in Norway eskers are rare, but that in Sweden they are both numerous and prominent, and this is in accordance with conditions as the slopes are steeper and more mountainous in Norway than in Sweden, and eskers if formed, would be more easily swept away.

The fact that most of the esker ridges of Nova Scotia and Eastern United States have been but slightly disturbed by eroding influences where they were supposed to have been most exposed to them, shows that neither marine nor flluviatile agencies were active.

No Marine Action.—On the coast of Maine, where a post-glacial elevation took place, there is no evidence of marine action on the eskers; therefore they must have retained their protective covering of ice until after the sea had retired.

A Natural Conclusion.—The natural conclusion is that eskers could be formed in glacier crevasses, but could not by any possibility be formed in subglacial streams; and being confined between these walls of ice, the contents could not be eroded to any extent until the disappearance, or partial disappearance, of the ice in the next interglacial age exposed them to view. Thus protected, they have preserved their special characters. When an increasing temperature began to melt the ice, subglacial streams and leakage would carry off without doubt much of the excess of water from the crevasses, thus preventing erosion and transportation of the elevated portions of transverse eskers. The proof of this is that these uneroded ridges are still to be seen in their original positions; so when the last fragments of the ice shed disappeared it left the gravel ridges reposing in almost their present form, except where since denuded by brooks or rivers.

Potholes and Gaps. Potholes, gaps and small kames could be, and probably were, formed by surface streams

pouring into the crevasses, but as this process is beyond the reach of observation, it can only be considered as a theory with the probabilities in its favor.

Formation of Eskers.—When in the latest stage of ice melting, local glaciers took the place of the continental ice sheet, those ice sheets on level ground naturally ceased to move while those on sloping ground continued their motion. The result could only be that these eskers on sloping ground continued to move and were eroded or modified, while those on level ground remained unaltered, except here and there by stream erosion.

How far the local and general slopes, or local and central watersheds of a country acted as a cause in the formation of crevasses, remains for future investigators to decide.

Emergence of Eskers.—Until distinctly contrary evidence shall be brought to bear, I shall feel justified in claiming that the evidence so far adduced points to the theory that nearly all, if not all of our eskers, were formed in the crevasses of a continental ice sheet. This ice sheet moving toward the lower ground carries with it the contents of the crevasses, eroded and gathered up as it proceeds. Crevasses, usually formed on watersheds, in valleys, or on the edge of declivities, may have moved one or one hundred miles with their load of debris before the increasing temperature dissolved the enclosing ice walls and disclosed the material within. In short, the subglacial drainage system had nothing to do with the origin of eskers and only denuded them in the latest stage of the glacial age.

Only Reasonable Theory.—This is the only explanation that will solve the puzzle of the uneroded and unmoved eskers so often seen in positions exposed particularly to erosion.

In eskers we have an example of the rarest and oldest of glacial deposits, the first to be formed but the last to be laid bare to aerial erosion, hence their preservation and their peculiar characteristics.

Crevasse Theory Supported by Facts. Thousands of pages have been written on the origin of eskers without one theory accounting for all the facts. But in the crevasse theory we have a simple explanation which is supported by every known fact.

Investigation Needed.—In offering to the Institute this explanation of the origin of these curious gravel ridges, I may be calling for criticism, and rightly so, as there are many points needing investigation and comparison which my limited leisure prevents me from carrying through. I know that in advancing this theory of origin I am going counter to the opinions of many men of distinguished reputation including Nansen, Nordenskjold, Peary, Stone, Wright, Winchell, and a number of others. But these opinions conflict largely with the evidence as now understood, and which has been brought forward to support them. Their several varied theories show selections from the most plausible but still unsatisfactory opinions. While such doubt exists there is room for investigation.

Former Estimates.—I am encouraged in advancing this opinion by the fact that in 1894 in a paper read before the Institute I claimed 28,000 feet as the least thickness of the gold-bearing formation of Nova Scotia. That statement has been completely verified by the labors of Mr. Faribault of the Canadian Geological Survey. But another distinguished worker on that survey sent me a post-card criticism, with the remark that I would change my opinions with more years and experience.

Is This Theory New?—With this lesson to encourage me, I have ventured this theory of the origin of eskers; however, I cannot say positively that it has not already been given in detail in some of the voluminous literature relating to the Glacial Geology of Europe.

In the question of the nature and origin of eskers we have a large field for investigation which will take many years to exhaust. No excavations have been undertaken here

to learn in detail the structure of an esker. Some structural secrets may have been revealed in road cuttings, but so far the disturbed and cross-bedded stratification seems only to have increased the mystery of their origin.

Nature's Record.—The history of these strange ridges lies hidden in their bosoms, and to the earnest investigator the record is plain. Every descent and ascent, every layer of gravel, sand or clay, every polished stone, irregularity, or sign of orderly arrangement, has a plainly written lesson that even an amateur may learn. It would give me much pleasure to pursue this and other investigations to a finish, but necessity compels me to leave the task to others.

Before closing, I should like to offer a few suggestions to students in this branch of Glacial Geology. Among the well defined eskers that can be investigated, that at Nine Mile River, Hants County, is probably the most conveniently situated for exploration, and I trust that when peace again gives the war weary world a little leisure, the suggestions following may be considered worthy of attention.

Suggestions for Future Work.—Some of the points requiring elucidation are the following:

1. The necessity of deciding by excavation, in which way the current which formed the esker, had run.

2. By examination of the debris to discover its source, its time of exposure to erosive action, and the power of the current depositing it.

3. By contour surveys and correct mapping, to discover the influence of surrounding slopes and drainage channels, and to find out how far watersheds and valleys determined the position and course of crevasses and their resulting eskers.

4. By comparison with other glacial deposits to discover whether the same agencies and influencies operated on both.

5. By examination of the junction of eskers with modified or unmodified drift to detect their relative ages.

6. By examination of the line of deposition to discover some trace on the surrounding drift of the great erosive power of a stream supposed to have flowed under a tremendous pressure as in a subglacial channel.

7. By examination of the gaps and kames interrupting eskers to find out if they are merely reformed eskers, or places in which there never was an esker.

drainage, and receiving the flow of water and sediment from above its level, the esker becomes in time an immense bank of water worn gravel, like those on the Ashuanippi and other rivers in Labrador. This condition would undoubtedly continue until the disappearance of the ice from the low lands allowed the sediment-charged waters to retire to their present beds. Thus all features of eskers are accounted for except those due to the most recent action of the present streams.

A. C. Lowe and others, in their explorations of Northern Canada, note the immense eskers of Labrador, especially one of 100 miles long, hundreds of feet wide and 40 to 60 feet high. The Hamilton, Ashuanippi and Dobuant Rivers are noted for their great valley eskers as well as other smaller but well developed ones on higher ground. Like all other valley eskers, they owe their birth and growth to a crevasse which formed when that part of Canada was still under the northern ice sheet.

Transverse Crevasses.—The larger visible crevasses of Arctic and Antarctic regions were formed across the course of ice movement, just as in Nova Scotia and most important eskers lie across the courses of both drainage and ice movement. What deposits these great crevasses actually contain will be unknown until a future interglacial age lays bare the earth probably 5,000 feet beneath the present surface. That they contain debris is both possible and probable, as we know that the edges of these crevasses have the same eroding power as the edge of the ice front. This, however, we cannot see.

The Crevasse Theory of the Origin of Eskers.—But this we know:

1. That the visible crevasses run across the course of ice movement as the majority of our eskers do.

2. That they cut across all minor undulations as our eskers do.

3. That the true drainage channels cut across and drain these crevasses, thus preventing them from becoming torrents as they would be if they were the *only* drainage channels. The same conditions probably prevailed in Nova Scotia where the streams cross the eskers.

4. Systems of diverging fissures, caused probably by the ice sheet passing over a hill or mountain spur, have been seen by Shackleton. Corresponding systems of diverging eskers have been seen in Maine and possibly in other countries.

5. Therefore we know that these crevasses are not a part of the permanent drainage system of Nova Scotia, Sweden or Eastern America.

6. That these transverse crevasses are being carried forward with all that is in them, with slow but invincible power, undoubtedly causing distorted stratification, and a mixed condition of the contents, such as we actually see in our own eskers, is evident.

7. If there is debris for the subglacial stream to gather up and transport there must be also debris for the transverse crevasse to gather and transport.

8. While the stream gathers debris only from its line of drainage, the crevasse would gather debris from the whole breadth of country behind it, hence the accumulations must be somewhat different in each. So too, is there a difference to some extent between the contents of the eskers and the valley kames of Nova Scotia.

9. As to the origin of the esker contents, Prof. Russell says that the lower 50 feet of the Malaspina glacier contains much earth, pebbles and other eroded material; the same is said of some of the Swiss glaciers.

10. Glaciers carrying debris at last come to a stand-still, and when melting the crevasses must leave their contents behind them in a comparatively undisturbed condition, altogether different from that of the stream gravels and other modified glacial deposits in the line of drainage, as is evident in Nova Scotia.

The evidence elsewhere is much the same as here. Nansen tells that in Norway eskers are rare, but that in Sweden they are both numerous and prominent, and this is in accordance with conditions as the slopes are steeper and more mountainous in Norway than in Sweden, and eskers if formed, would be more easily swept away.

The fact that most of the esker ridges of Nova Scotia and Eastern United States have been but slightly disturbed by eroding influences where they were supposed to have been most exposed to them, shows that neither marine nor fluviatile agencies were active.

No Marine Action.—On the coast of Maine, where a post-glacial elevation took place, there is no evidence of marine action on the eskers; therefore they must have retained their protective covering of ice until after the sea had retired.

A Natural Conclusion.—The natural conclusion is that eskers could be formed in glacier crevasses, but could not by any possibility be formed in subglacial streams; and being confined between these walls of ice, the contents could not be eroded to any extent until the disappearance, or partial disappearance. of the ice in the next interglacial age exposed them to view. Thus protected, they have preserved their special characters. When an increasing temperature began to melt the ice, subglacial streams amd leakage would carry off without doubt much of the excess of water from the crevasses, thus preventing erosion and transportation of the elevated portions of transverse eskers. The proof of this is that these uneroded ridges are still to be seen in their original positions; so when the last fragments of the ice shed disappeared it left the gravel ridges reposing in almost their present form. except where since denuded by brooks or rivers.

Potholes and Gaps.—Potholes, gaps and small kames could be, and probably were, formed by surface streams

pouring into the crevasses, but as this process is beyond the reach of observation, it can only be considered as a theory with the probabilities in its favor.

Formation of Eskers.—When in the latest stage of ice melting, local glaciers took the place of the continental ice sheet, those ice sheets on level ground naturally ceased to move while those on sloping ground continued their motion The result could only be that these eskers on sloping ground. continued to move and were eroded or modified, while those on level ground remained unaltered, except here and there by stream erosion.

How far the local and general slopes, or local and central watersheds of a country acted as a cause in the formation of crevasses, remains for future investigators to decide.

Emergence of Eskers.—Until distinctly contrary evidence shall be brought to bear, I shall feel justified in claiming that the evidence so far adduced points to the theory that nearly all, if not all of our eskers, were formed in the crevasses of a continental ice sheet. This ice sheet moving toward the lower ground carries with it the contents of the crevasses, eroded and gathered up as it proceeds. Crevasses, usually formed on watersheds, in valleys, or on the edge of declivities, may have moved one or one hundred miles with their load of debris before the increasing temperature dissolved the enclosing ice walls and disclosed the material within. In short, the subglacial drainage system had nothing to do with the origin of eskers and only denuded them in the latest stage of the glacial age.

Only Reasonable Theory.—This is the only explanation that will solve the puzzle of the uneroded and unmoved eskers so often seen in positions exposed particularly to erosion.

In eskers we have an example of the rarest and oldest of glacial deposits, the first to be formed but the last to be laid bare to aerial erosion, hence their preservation and their peculiar characteristics.

Crevasse Theory Supported by Facts.—Thousands of pages have been written on the origin of eskers without one theory accounting for all the facts. But in the crevasse theory we have a simple explanation which is supported by every known fact.

Investigation Needed.—In offering to the Institute this explanation of the origin of these curious gravel ridges, I may be calling for criticism, and rightly so, as there are many points needing investigation and comparison which my limited leisure prevents me from carrying through. I know that in advancing this theory of origin I am going counter to the opinions of many men of distinguished reputation including Nansen, Nordenskjold, Peary, Stone, Wright, Winchell, and a number of others. But these opinions conflict largely with the evidence as now understood, and which has been brought forward to support them. Their several varied theories show selections from the most plausible but still unsatisfactory opinions. While such doubt exists there is room for investigation.

Former Estimates.—I am encouraged in advancing this opinion by the fact that in 1894 in a paper read before the Institute I claimed 28,000 feet as the least thickness of the gold-bearing formation of Nova Scotia. That statement has been completely verified by the labors of Mr. Faribault of the Canadian Geological Survey. But another distinguished worker on that survey sent me a post-card criticism, with the remark that I would change my opinions with more years and experience.

Is This Theory New?—With this lesson to encourage me, I have ventured this theory of the origin of eskers; however, I cannot say positively that it has not already been given in detail in some of the columinous literature relating to the Glacial Geology of Europe.

In the question of the nature and origin of eskers we have a large field for investigation which will take many years to exhaust. No excavations have been undertaken here

to learn in detail the structure of an esker. Some structural secrets may have been revealed in road cuttings, but so far the disturbed and cross-bedded stratification seems only to have increased the mystery of their origin.

Nature's Record.—The history of these strange ridges lies hidden in their bosoms, and to the earnest investigator the record is plain. Every descent and ascent, every layer of gravel, sand or clay, every polished stone, irregularity, or sign of orderly arrangement, has a plainly written lesson that even an amateur may learn. It would give me much pleasure to pursue this and other investigations to a finish but necessity compels me to leave the task to others.

Before closing, I should like to offer a few suggestions to students in this branch of Glacial Geology. Among the well defined eskers that can be investigated, that at Nine Mile River, Hants County, is probably the most conveniently situated for exploration, and I trust that when peace again gives the war weary world a little leisure, the suggestions following may be considered worthy of attention.

Suggestions for Future Work.—Some of the points requiring elucidation are the following:

1. The necessity of deciding by excavation, in which way the current which formed the esker, had run

2. By examination of the debris to discover its source, its time of exposure to erosive action, and the power of the current depositing it.

3. By contour surveys and correct mapping, to discover the influence of surrounding slopes and drainage channels, and to find out how far watersheds, and valleys determined the position and course of crevasses and their resulting eskers.

4. By comparison with other glacial deposits to discover whether the same agencies and influencies operated on both.

5. By examination of the junction of eskers with modified or unmodified drift to detect their relative ages.

6. By examination of the line of deposition to discover some trace on the surrounding drift of the great erosive power of a stream supposed to have flowed under a tremendous pressure as in a subglacial channel.

7. By examination of the gaps and kames interrupting eskers to find out if they are merely reformed eskers, or places in which there never was an esker.

The Phenology of Nova Scotia, 1917—By A. H. MacKay, Ll. D.

(Read by title 14 May, 1918.)

These observations were made by the school children of the Province of Nova Scotia as a part of the Nature Study work prescribed. The pupils report by bringing into the school-room the flowering or other specimens when first observed, for authoritative determination by the teacher who generally credits the first finder by placing the name and the observation on the honor roll section of the blackboard for the day. The teacher after testing the correctness of the observation, marks it on the schedule with which every teacher is provided—a copy of which is sent in to the Inspector with the school returns at the end of June and January.

The following tables are complied from 186 of the best schedules out of the 450 sent in. The selections were made and complied under the direction of Mr. H. R. Shinner, B. A. and Miss M. G. McLeod, of the Education Department.

The schedules for each year are carefully bound up in a large annual volume which is placed in the Provincial Museum and Science Library where they can be used by students of climate, etc. The compilers of the phenochrons of the different belts, slopes or regions, have been rural science teachers who have most distinguished themselves as instructors. They were selected for the purpose on the recommendation of the Director of rural science education. The sheets from which the provincial phenochrons are calculated are also bound in annual folio volumes for ease of consultation and preservation.

The Province is divided into its main climate slopes or regions not always coterminous with the boundaries of counties. Slopes, especially those to the coast, are subdivided into belts, such as (a) the coast belt, (b) the low inland belt and (c) the high inland belt, as below:—

No.	Regions or Slopes.	Belts.
I.	Yarmouth and Digby Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
II.	Shelburne, Queens & Lunenburg Co.'s,	" " "
III.	Annapolis and Kings Counties,	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.
IV.	Hants and Colchester Counties,	(a) Coast, (b) Low Inlands, (c) High Inlands.
V.	Halifax and Guysboro Counties,	" " "
VI.A.	Cobequid Slope (to the south),	" " "
VI.B.	Chignecto Slope (to the northwest)	" " "
VII.	Northumberland Straits Slope (to the n'h)	" " "
VIII.	Richmond & Cape Breton Co.'s,	" " "
IX.	Bras d'Or Slope (to the southeast),	" " "
X.	Inverness Slope (to Gulf, N. W.),	" " "

The ten *regions* are indicated on the outline map on the next page.

THE LOCAL COMPILERS FOR EACH REGION, 1917.

Region No.		Region No.	
I.	Miss Helen Pitman, Brooklyn, Yar. Co.	VI.a	Mr. R. N. Bagnell, Great Village, Col. Co.
II.	Mr. G. L. Leslie, Mahone, Lun. Co.	VI.b	Miss E. A. O'Regan, Parrsboro, Cumb. Co.
III.	Miss Anna R. McGregor, Kentville, Kings Co.	VII.	Miss Flora Zwicker, Pugwash, Cumb. Co.
IV.	Mr. R. H. Wetmore, Truro, Col. Co.	VIII.	Mr. Dara Cochrane, Sydney, C. B.
V.	Miss Katherine Manson, Dartmouth, Hfx. Co	IX & X.	Mr. L. A. DeWolfe, Truro, Col. Co.

THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

THE PHENOLOGY OF NOVA SCOTIA, 1917.

[Compiled from the best 186 out of 450 local observation schedules.]

Year 1917.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	301
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

When First Seen. (Observation Regions.)

Species	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Chignecto and Cobequid Slope	6b. Chignecto and Cobequid Slope	7. Northumberland Straits Slope	8. Richmond and Cape Breton	9 & 10. Bras d'Or and Inverness Slope	Average Dates
1. Alnus incana, Wild	110	106	109	106	129	123	104	114	128	107	113
2. Populus tremuloides	124	117	161	118	....	....	127	134	121	120	127
3. Epigea repens, L.	95	100	105	109	107	115	111	110	118	125	109
4. Equisetum arvense	115	124	127	129	126	120	134	138	145	131	128
5. Sanguinaria Canadensis	....	121	129	126	....	....	153	141	135	122	132
6. Viola Blanda	119	123	132	130	129	123	131	135	131	140	129
7. Viola palmata, *cucullata*	122	127	135	133	131	134	137	139	137	113	133
8. Hepatica triloba, etc.	140	125	124	...	.	...	....	129	.	166	136
9. Acer rubrum	130	135	132	133	132	.	141	141	140	141	137
10. Fragaria Virginiana	124	127	131	131	129	130	132	136	133	138	131
11. Fragaria Virginiana (Fruit ripe)	169	170	171	170	174	169	175	174	171	178	172
12. Taraxacum officinale	124	129	136	134	136	136	143	141	139	143	136
13. Erythronium Americanum	....	143	143	132	144	138	142	138	158	142	142
14. Coptis trifolia	130	135	147	142	137	140	145	145	148	146	141
15. Claytonia Caroliniana	115	121	129	135	145	121	141	137	144	142	133
16. Nepeta Glechoma	148	136	149	142	142	143	138	154	152	157	146
17. Amelanchier Candaensis	146	147	151	151	147	155	154	154	157	157	151
18. Amelanchier Canadensis (Fruit ripe)	....	....	...	...	....	...	228	...	.	..	228

When Becoming Common. (Observation Regions.)

Species	Average Dates	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester	5. Halifax and Guysboro	6a. Chignecto and Cobequid Slope	6b. Chignecto and Cobequid Slope	7. Northumberland Straits Slope	8. Richmond and Cape Breton	9 & 10. Bras d'Or and Inverness Slope
1. Alnus incana, Wild	121	117	112	118	109	134	147	110	120	133	113
2. Populus tremuloides	127	130	128	117	121	..	...	134	132	126	128
3. Epigea repens, L.	118	105	109	114	116	116	124	118	121	125	133
4. Equisetum arvense	133	119	127	128	135	132	123	138	144	149	132
5. Sanguinaria Canadensis	137	....	126	....	130	.	.	159	146	138	135
6. Viola Blanda	141	128	130	144	138	135	132	138	141	138	147
7. Viola palmata, *cucullata*	141	133	134	143	139	138	142	144	145	145	147
8. Hepatica triloba, etc.	143	138	128	149	.				134		169
9. Acer rubrum	144	141	140	141	140	145	144	146	146	147	148
10. Fragaria Virginiana	142	136	136	142	141	142	145	145	146	144	146
11. Fragaria Virginiana (Fruit ripe)	178	178	178	176	179	177	181	179	179	180	178
12. Taraxacum officinale	143	138	136	143	142	145	139	149	144	146	149
13. Erythronium Americanum	150	165	155	153	139	148	143	148	144	162	144
14. Coptis trifolia	149	138	142	140	177	143	145	150	152	150	159
15. Claytonia Caroliniana	143	129	130	148	143	147	128	150	142	[illegible]	151
16. Nepeta Glechoma	154	161	142	159	151	147	147	143	160	159	169
17. Amelanchier Candaensis	157	156	153	156	155	155	161	157	159	[illegible]	[illegible]
18. Amelanchier Canadensis (Fruit ripe)	232	.	..	.	.	.		228	224	244	

THE PHENOLOGY OF NOVA SCOTIA, 1917—*Continued*

Year 1917.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

When First Seen. Observation Regions.

Year 1917.	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chignecto and Cobequid Slope.	6b. Chignecto and Cobequid Slope.	7. Northumberland Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inverness Slope.	Average Dates.
19. Prunus Pennsylvanica	154	154	155	156	156	162	157	159	162	164	158
20. Prunus Pennsylvanica (Fruit ripe)	...	...	159	...	246	...	230	...	226	...	217
21. Vaccinium Can. and Penn.	141	146	156	154	155	156	159	158	162	161	155
22. Vaccinium Can. and Penn (Fruit ripe)	...	180	211	219	216	...	215	...	226	...	211
23. Ranunculus acris	155	156	159	153	161	151	164	163	165	167	159
24. R. repens	168	159	167	164	163	165	168	168	169	166	166
25. Trill. erythrocarpum	149	152	150	150	151	150	153	155	157	179	155
26. Rhododendron Rhodora	153	157	161	161	157	160	163	159	165	165	160
37. Cornus Canadensis	153	154	157	157	158	154	159	161	161	166	158
28. Cornus Canadensis (Fruit ripe)	...	...	164	245	175	...	...	216	213	...	202
29. Trientalis Americana	153	158	155	154	158	155	162	158	157	161	157
30. Clintonia borealis	156	157	158	163	161	162	166	162	166	165	162
31. Calla palustris	156	165	163	166	163	165	160	168	160	164	163
32. Cypripedium acaule	162	159	164	164	157	164	166	168	169	171	164
33. Sisyrinchium angustifolium	163	165	165	165	164	169	163	168	168	174	166
34. Linnæa borealis	168	169	165	172	169	171	172	175	164	168	169
35. Kalmia glauca	164	161	160	163	165	165	163	168	163	169	164
36. Kalmia angustifolia	169	170	163	168	171	168	165	137	168	172	165
37. Cratægus exyacantha	168	167	166	170	169	170	167	167	171	172	169
38. Cratægus coccinea, etc.	168	168	167	172	169	...	168	167	167	171	168
39. Iris versicolor	167	169	172	171	169	177	172	171	175	173	171
40. Chrysanthemum Leucanthemum	169	169	171	171	172	170	174	172	174	173	171
41. Nuphar advena	175	171	173	167	173	...	174	173	174	173	173
42. Ribus strigosus	171	168	162	163	167	159	173	162	164	162	165
43. **Rubus strigosus** (Fruit ripe)	...	211	...	208	222	...	...	210	...	...	212

When Becoming Common. Observations Regions.

Year 1917.	Average Dates.	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chignecto and Cobequid Slope.	6b. Chignecto and Cobequid Slope.	7. Northumberland Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inverness Slope.
19. Prunus Pennsylvanica	163	160	159	161	161	161	167	161	163	167	166
20. Prunus Pennsylvanica (Fruit ripe)	243	...	...	...	...	250	...	...	237	242	...
21. Vaccinium Can. and Penn.	161	153	152	161	161	163	160	164	163	167	168
22. Vaccinium Can. and Penn (Fruit ripe)	228	...	...	220	242	223	...	...	220	235	...
23. Ranunculus acris	165	163	162	166	166	159	160	167	168	171	172
24. R. repens	169	173	163	174	169	169	158	170	173	172	171
25. Trill. erythrocarpum	159	157	157	156	158	159	155	158	160	162	167
26. Rhododendron Rhodora	166	160	162	165	165	163	163	166	164	171	178
37. Cornus Canadensis	163	160	160	160	162	162	159	166	166	164	167
28. Cornus Canadensis (Fruit ripe)	205	...	...	164	245	180	...	...	220	218	...
29. Trientalis Americana	163	158	164	162	160	164	163	165	163	163	169
30. Clintonia borealis	169	162	163	164	168	169	165	169	168	161	169
31. Calla palustris	168	163	172	...	171	165	167	167	173	166	108
32. Cypripedium acaule	168	167	165	169	160	163	167	167	172	175	175
33. Sisyrinchium angustifolium	172	173	171	169	170	169	171	171	173	172	177
34. Linnæa borealis	174	172	174	170	174	174	...	176	178	171	...
35. Kalmia glauca	169	172	166	168	170	171	169	167	104	162	172
36. Kalmia angustifolia	172	173	171	168	172	175	175	167	172	173	177
37. Cratægus exyacantha	172	173	172	173	169	174	171	175	174	174	170
38. Cratægus coccinea, etc.	172	172	173	171	174	172	...	171	171	172	172
39. Iris versicolor	176	173	174	176	175	174	180	175	176	180	178
40. Chrysanthemum Leucanthemum	176	173	174	175	176	177	176	179	177	179	177
41. Nuphar advena	176	177	172	179	173	177	...	178	179	179	177
42. Ribus strigosus	170	173	173	168	171	172	164	175	167	170	176
43. **Rubus strigosus** (Fruit ripe)	229	...	215	...	...	227	...	...	216	232	...

169	172	178	178	182	.	.	175	177	.	176	44. Rhinanthus Crista-galli	179	176	177	.	180	186			178	179	
174	172	173	167	167	162	171	167	163	169	168	45. Rugus villosus	174	178	173	179	170	171	172	175	173	169	180
245	....	173	....	230	....	233	232	244	....	223	46. Rubus villosus (Fruit ripe)	232	....	....	177	247	238	....	240	242	249	..
173	171	176	172	175	177	170	171	174	175	173	47. Sarracenia purpurea	177	175	176	177	177	178	180	....	175	179	179
172	174	153	167	181	135	179	175	224	....	167	48. Brunella vulgaris	175	180	180	160	167	189	....	....	177	178	...
175	173	173	179	176	177	178	177	209	....	179	49. Rosa lucida	183	179	180	174	180	177	179	...	177	215	..
172	171	165	172	172	176	177	174	168	176	172	50. Leontodon autumnale	176	172	172	179	176	178	176	180	177	175	179
163	168	170	166	173	....	164	172	164	....	167	51. Linaria vulgaris	171	163	171	....	170	178	..	169	173	173	.
149	144	147	148	143	142	152	148	144	151	147	52. Trees appear green	158	158	153	156	162	155	155	159	157	155	166
152	150	158	120	151	162	160	158	160	159	153	53. Ribes rubrum (cultivated)	163	157	157	161	159	158	168	164	164	170	172
....	....	....	....	198	....	....	204	231	....	211	54. Ribes rubrum (Fruit ripe)	239	....	....	....	....	....	....	....	....	239	...
151	156	156	157	155	165	161	159	161	163	158	55. R. nigrum (cultivated)	161	158	162	164	162	160	170	164	164	164	169
....	....	....	....	....	....	....	200	210	....	210	56. R. nigrum (Fruit ripe)	214	....	....	....	....	....	....	....	209	220	.
155	158	157	160	159	164	163	163	163	164	161	57. Prunus Cerasus	164	163	162	162	163	160	168	166	166	168	167
....	....	....	....	215	....	....	209	223	....	219	58. Prunus Cerasus (Fruit ripe)	222	....	....	....	....	....	....	....	215	229	...
163	160	157	162	164	165	165	163	166	165	163	59. Prunus domestica	168	171	165	163	165	168	168	167	167	171	173
160	160	160	163	162	168	166	165	166	169	164	60. Pyrus Malus	169	168	167	168	168	165	173	168	169	170	173
169	168	169	167	166	171	169	168	173	175	169	61. Syringa vulgaris	174	173	173	174	172	171	177	173	173	177	175
166	167	168	167	169	167	174	172	170	177	170	62. Trifolium repens	174	172	173	174	175	172	176	179	177	175	171
156	161	165	168	168	169	170	169	170	176	167	63. Trifolium pratense	173	167	169	171	172	173	178	179	177	173	176
166	160	167	171	169	170	162	173	170	167	167	64. Phelum pratense	174	175	165	172	175	173	179	163	178	176	174
....	178	....	....	195	....	179	192	203	....	186	65. Solanum tubersum	186	....	....	180	...	203	..	...	....	215	.
102	116	118	128	119	110	114	131	113	122	118	66. Ploughing (first of season)	128	113	126	130	141	130	119	128	145	122	126
127	121	137	139	131	131	137	150	137	141	135	67. Sowing	146	138	131	146	165	136	138	151	156	147	152
113	124	139	142	132	129	138	142	129	135	132	68. Potato-planting	144	128	135	148	155	142	135	154	154	101	148
135	125	135	130	146	129	116	136	123	123	130	69. Sheep-shearing	140	140	135	143	150	151	149	120	151	135	131
181	178	157	221	207	....	....	207	212	....	193	70. Hay-cutting	216	....	....	....	....	212	....	....	215	222	...
250	....	240	253	248	....	239	238	243	241	244	71. Grain-cutting	253	260	....	241	243	254	....	247	246	252	..
251	236	255	275	273	....	268	258	264	282	263	72. Potato-digging	271	258	....	271	267	282	....	275	279	270	298
76	87	112	74	90	....	90	94	97	113	93	73a. Opening or rivers	....	....	....	....	....	....	....	....	....	....	....
86	102	....	97	101	....	113	74	107	122	100	73b. Opening of lakes	....	....	....	....	....	....	....	....	....	....	....
115	127	125	120	125	125	123	134	125	127	125	74a. Last snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
128	131	108	120	131	129	126	137	132	131	127	74b. Last snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
123	111	135	95	120	....	121	134	139	139	124	75a. Last spring frost—hard	....	....	....	....	....	....	....	....	....	....	....
129	132	....	140	141	....	147	151	159	134	142	75b. Last spring frost—hoar	....	....	....	....	....	....	....	....	....	....	....
98	98	114	96	115	....	94	137	55	107	100	76a. Water in streams—high	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	..	263	....	....	263	76b. Water in streams—low	....	....	....	....	....	....	....	....	....	....	....
248	....	241	252	246	....	251	253	261	251	250	77a. First autumn frost—hoar	....	....	....	....	....	....	....	....	....	....	....
255	....	290	302	283	....	270	284	286	....	273	77b. First autumn frost—hard	....	....	....	....	....	....	....	....	....	....	....
307	306	297	313	283	....	308	309	290	309	302	78a. First snow to fly in air	....	....	....	....	....	....	....	....	....	....	....
308	309	308	317	307	....	310	312	315	314	311	78b. First snow to whiten ground	....	....	....	....	....	....	....	....	....	....	....
15	....	332	348	361	....	....	327	187	....	261	79a. Closing of lakes	....	....	....	....	....	....	....	....	....	....	....
22	....	....	345	340	....	...	331	173	....	242	79b. Closing of rivers	....	....	....	....	....	....	....	....	....	....	....
91	86	96	84	93	85	86	93	94	98	91	81a. Wild ducks migrating, N.											
312	....	302	305	....	....	254	292	264	...	288	81b. Wild ducks migrating, S.	....	....	....	....	....	....	....	....	....	....	....
88	87	90	82	85	87	86	86	87	85	86	82a. Wild geese migrating, N.	....	....	....	....	....	....	....	....	....	....	....
302	....	326	314	96	....	....	271	274	...	263	82b. Wild geese migrating, S.	....	....	....	....	....	....	....	....	....	....	....

THE PHENOLOGY OF NOVA SCOTIA, 1917.—*Continued.*

YEAR 1917.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For leap year add one to each except January.

WHEN FIRST SEEN. — OBSERVATION REGIONS.

Year 1917	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chignecto and Cobequid Slope.	6b. Chignecto and Cobequid Slope.	7. Northumberland Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inverness Slope.	Average Dates
83. Melospiza fasciata (North)	84	85	88	89	90	87	83	88	98	95	88
84. Turdus migratorius (North)	83	85	82	80	86	84	85	85	93	90	85
85. Junco hiemalis (North)	89	87	92	89	....	83	88	94	91	101	90
86. Actitis macularia (North)	....	128	134	129	131	144	....	143	128	117	132
87. Sturnella magna (North)	116	121	130	122	133	....	....	131	117	....	124
88. Ceryle Alcyon (North)	135	123	125	130	125	....	139	134	125	143	131
89. Dendrœca coronata (North)	139	136	160	144	100	114	114	142	99	139	129
90. Dendrœca Estiva (North)	139	119	151	141	142	134	132	151	121	155	138
91. Zonotrichia alba (North)	133	129	129	129	132	....	109	139	108	136	127
92. Trochilus colubris (North)	152	147	148	134	161	157	150	156	172	165	154
93. Tyrannus Carolinensis (North)	123	151	136	148	137	151	142	150	90	137	146
94. Dolychonyx oryzivorus (North)	128	....	139	144	125	157	152	141	150	159	143
95. Apinis tristis (North)	136	151	153	140	139	158	156	158	126	....	146
96. Setophaga ruticilla (North)	144	158	164	145	144	144	....	162	....	157	152
97. Ampelis cedrorum (North)	120	157	154	163	147	152	163	160	....	....	152
98. Chordeiles Virginianus (North)	114	151	146	152	144	157	....	140	151	155	147
99. First piping of frogs	100	103	107	106	110	110	109	103	111	118	108
00. First appearance of snakes	102	107	119	123	128	119	127	124	125	137	121

WHEN BECOMING COMMON. — OBSERVATION REGIONS.

Year 1917	Average Dates.	1. Yarmouth and Digby	2. Shelburne, Queens and Lunenburg	3. Annapolis and Kings	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chignecto and Cobequid Slope.	6b. Chignecto and Cobequid Slope.	7. Northumberland Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inverness Slope.
83. Melospiza fasciata (North)	....	....	....	....	....	....	....	....	....	....	....
84. Turdus migratorius (North)	....	....	....	....	....	....	....	....	....	....	....
85. Junco hiemalis (North)	....	....	....	....	....	....	....	....	....	....	....
86. Actitis macularia (North)	....	....	....	....	....	....	....	....	....	....	....
87. Sturnella magna (North)	....	....	....	....	....	....	....	....	....	....	....
88. Ceryle Alcyon (North)	....	....	....	....	....	....	....	....	....	....	....
89. Dendrœca coronata (North)	....	....	....	....	....	....	....	....	....	....	....
90. Dendrœca Estiva (North)	....	....	....	....	....	....	....	....	....	....	....
91. Zonotrichia alba (North)	....	....	....	....	....	....	....	....	....	....	....
92. Trochilus colubris (North)	....	....	....	....	....	....	....	....	....	....	....
93. Tyrannus Carolinensis (North)	....	....	....	....	....	....	....	....	....	....	....
94. Dolychonyx oryzivorus (North)	....	....	....	....	....	....	....	....	....	....	....
95. Apinis tristis (North)	....	....	....	....	....	....	....	....	....	....	....
96. Setophaga ruticilla (North)	....	....	....	....	....	....	....	....	....	....	....
97. Ampelis cedrorum (North)	....	....	....	....	....	....	....	....	....	....	....
98. Chordeiles Virginianus (North)	....	....	....	....	....	....	....	....	....	....	....
99. First piping of frogs	....	....	....	....	....	....	....	....	....	....	....
00. First appearance of snakes	....	....	....	....	....	....	....	....	....	....	....

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1917.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chig. and Cobequid Slope.	6b. Chig. and Cobequid Slope.	7. Northumb. Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inv. Slope.	Total 1917.
									39	39
							41^{2}			41^{2}
	57^{4}									57^{4}
58									58	
							85			85
			89							89
93^{5}										93^{5}
									99	99
			106							106
		108								108
111^{3}	111^{3}	111^{7}	111^{2}	111^{2}	111^{2}	111^{7}	111^{4}			111^{70}
112			112^{2}	112				112	112^{4}	112^{9}
								114	114	114^{2}
118				118			118			118^{3}
			119							119
		121								121
			122					122		122^{2}
			129	129			129^{8}	129		129^{11}
		135								135
				141	141					141^{2}
143^{7}	143^{2}	143^{3}					143^{3}			143^{15}
			147							147
							153^{11}	153^{6}	153	153^{18}
154^{4}	154^{5}	154^{22}	154^{3}	154^{2}	154^{3}	154^{7}	154^{7}	154		154^{64}
			155^{2}		155	155^{2}	155^{4}		155^{3}	155^{11}
		160	160							160^{2}
									161	161
163	163									163^{2}
	170									170
	171^{3}	171^{6}	171						171	171^{11}
172										172
			173							173
		174					174	174	174^{3}	174^{6}
175^{3}	175^{3}			175						175^{7}
						177				177
			178			178^{2}	178^{11}			178^{4}
			179^{2}			179	179^{9}		179	179^{3}
						180	180			180^{2}

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA. 1917.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATIONS REGIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and Colchester.	5. Halifax and Guysboro.	6a. Chig. and Cobequid Slope.	6b. Chig. and Cobequid Slope.	7. Northumb. Straits Slope.	8. Richmond and Cape Breton.	9 & 10. Bras d'Or and Inv. Slope.	Total 1917.
181		181^{2}								181^{3}
									183	183
							186			186
							195			195
		197					197^{2}			197^{3}
							198			198
							203			203
		207								207
							208			208
							210			210
								254		254
			263^{3}	263			263	263^{4}		263^{11}
				273						273
								276		276
		278								278
	279	279				279^{2}				279^{4}
		290								290
			295				295	295		295^{3}
				298						298
			305							305
				307						307
								309		309
								310		310
								311		311
								314		314
								315		315
	328									328
								344		344
							363			363

Two Remarkable Skulls from the New Hebrides.—An Anthropological and Ethnological Study.—By John Cameron, M. D., D. Sc., F. R. S. E., Professor of Anatomy, Dalhousie University, Halifax, N. S.

Introduction.—The skulls that form the subject of this memoir came from South Malekula in the New Hebrides, a group of islands which is situated about nine hundred miles in a north easterly direction from the coast of Queensland and is definitely placed by geographers and ethnologists in Melanesia. The inhabitants(1) of this section of Oceania are more darkly complexioned than the inhabitants of the other section of Oceania termed Polynesia, but it is remarkable how much the skin pigmentation of the Melanesians varies in the different groups of islands. The reason for this is not far to seek for it is due to the intrusion of a lighter complexioned Polynesian strain which has become mingled in varying proportions with the black aboriginal element(2). This black aboriginal substratum is, however, everywhere dominant throughout the New Hebrides, and is characterised, in addition to the skin coloration, by crisp, curly, black hair, decided negroid features, an extreme dolichocephalic head and short stature, averaging five feet, four and one-half inches, which is decidedly lower than the Polynesian average of five feet, ten inches. The Melanesians were formerly classed by ethnologists as fierce, warlike savages, with a strong proclivity towards head-hunting expeditions and cannibalism. The language(3) spoken in Melanesia is a heterogeneous mixture, consisting mainly of archaic forms of the Malayo-Polynesian tongue, which was probably imposed upon the inhabitants in bygone ages by their Polynesian conquerors.

It is essential that I should make some reference to the ethnology of the Polynesians as their fortunes and misfortunes have been closely bound up with those of the Melanesians.[4] They are physically a very fine race, their average stature being as much as five feet, ten inches. Their features are remarkably regular, and in fact almost European in type,[5] the skull being on the borderland between orthognathism and mesognathism. The complexion is light brown and the hair straight, both these features being thus in strange contrast to the corresponding condition in the Melanesians. Moreover their mentality, their standard of civilization, and their codes of ethics are all of a decidedly higher[6] order. Their speech is a distinct offshoot of the ancient Malayo-Polynesian stock language. The extent of dialectic diversity in all the Archipelagoes of Polynesia is remarkably slight showing that close intercourse must have been maintained between the various groups of islands, which, it may be recollected, are separated in many cases by hundreds of miles of vast ocean. The Polynesians possess quite an elaborate mythology as those who have read Sir G. Grey's classic work[7] on the subject will testify. This will be found to have an important bearing on the two skulls which form the subject of this memoir. Their traditions are likewise of a remarkably high order and their arts and crafts have their own distinctive, though frequently crude qualities. These characteristics, racial attributes, and gifts will also be found referred to more fully in other sections of this memoir.

The skulls were presented to Dalhousie University by the Rev. Dr. Joseph Annand, a graduate of Pine Hill, who was a Canadian Presbyterian Missionary to the New Hebrides for the long period of forty years, from 1873 to 1913. I wish to express my indebtedness to this gentleman, as also to Dr. John Forrest and President A. S. Mackenzie of Dalhousie University, for the opportunity, thus obtained, of having studied two very unique anthropological specimens. On

removing the skulls from their box, I found that they presented quite a remarkable appearance, for on each there had been moulded in clay or some similar medium, with no small display of skill, the supposed facial features of the deceased. On investigating them further, it was seen that they exhibited many points of more than passing interest which were deemed worthy of being placed on record.

I wrote a letter to Dr. Annand inquiring about the racial characteristics of the New Hebridean inhabitants, and he very courteously sent me by return mail a very interesting account, in the course of which he stated that they were mainly Melanesian with some Polynesian admixture. His letter contained so many points bearing on the subject of this memoir that I decided to reproduce it *in extenso.*

"Your letter of yesterday asking for information relating to two New Hebrides skulls is before me. The history of the "clay facial masks" is, so far as the New Hebrides is concerned, non-existent. However I will mention some facts that may aid you in forming an opinion regarding them. The skulls were brought home to show a custom that prevails on South and South West Malekula only of the New Hebrides, namely the binding of the head in infancy to produce "long heads". Why this was first done no one now knows; but it continues because their fathers did it. It is the fashion. The clay mask is not essentially connected with the long skull for on other parts of the same island the human body is thus encased with clay and lime into mummy form. Some bodies have been taken from the island that passed as mummies. The chief preservative is lime (burned coral). The moulding of the masks is done over the body soon after death, and placed over a fire to dry and smoke. There is no burial where this custom prevails. The corpse is put up on a platform in a house or roof erected for the purpose. After the days of mourning are over (from fifty days and upward) the body gets no

more care. This manner of treating the corpse is not practised anywhere else in the New Hebrides group. On Aneityum (in the South) the bodies of all the common people were thrown into the sea. On some other islands burial was practised, but sometimes in very shallow graves. In other places bodies were put upon a kind of stage and left to decay away, and then the bones were used for tipping spears and arrows. The bodies of those killed were generally eaten.

"The New Hebrides are Melanesian with a very few traces of Polynesian tribes among them. A few canoes drifted at different times from the Eastern Islands (Tonga and Samoa) and never returned home against the prevailing east winds. On Malekula there is no trace of any Polynesian influence. The Maoris never have had any intercourse with the New Hebrideans.

"I should say that all or nearly all the different methods of disposing of the dead bodies arose from their belief regarding the future life. They appear in the Spirit World as they leave this, so ornamentation and ceremony must correspond with a man's social position.

"I am sorry that I cannot give you all the information desired."

The Sex of the Skulls.—Both skulls belong definitely to the male sex. The lines of muscular and ligamentous attachment in each are excessively developed, much more so, indeed, than in the average European skull. For example the curved lines of the occipital bone stand out prominently in the form of rough ridges. The external occipital protuberance projects markedly while the external occipital crest forms a thin obtrusive blade of bone. One would gather that they belonged to very muscular warriors. At any rate the owners must have led very strenuous active lives. Other sexual features prominently displayed are the large mastoid processes and the strongly projecting superciliary ridges, indicating of course an enormous degree of development

of the frontal air sinuses, which are such a marked feature of the Melanesian skull.

The Approximate Age of the Skulls.—The sutures in both are for the most part obliterated on the interior of the skulls, which would indicate an age somewhat beyond middle life. The outlines of all the sutures can be traced on the outer surface of both skulls. In No. 1 the sagittal, the coronal, and the upper portion of the lambdoid suture have become synostosed. In No. 2 on the other hand the whole of the lambdoidal suture is still markedly distinct, an interesting reminder of the fact that its period of obliteration usually follows that of the sagittal or coronal. One would gather from this that No. 2 skull belonged to a slightly younger individual, a statement which is supported by the fact that the teeth in No. 1 skull are more worn than those in No. 2. The squamous sutures, as one would expect, are still remarkably distinct and separate in both skulls, especially in No. 2.

The Cranial Capacity.—The capacity of No. 1 skull was found to be 1368 c. cm. It thus approached the lower limit of the mesocephalic class, but is well above the aboriginal Australian average of 1300 (Flower)[8] though it is decidedly below the Polynesian average of 1469 (Duckworth)[9]. The capacity of No. 2 skull proved to be 1395 c. cm. It is therefore slightly better than that of No. 1, though still comparatively low in the mesocephalic class.

The Horizontal Cranial Circumference.—The horizontal cranial circumference was measured over the glabella according to the plan of Sir William Turner[10]. It was 52.07 cm. in No. 1 skull and 53.49 in No 2 which would accord with the difference in capacity given in the preceding paragraph. The taking of this measurement proved somewhat difficult owing to marked flattening of the frontal regions of the skulls. It will be noted that these measurements are practically the same as that of the average European male skull

which is about 52.5 cm. (Quain)(11). This high figure may be partially explained by the undue prominence of the superciliary ridges. Apart from this it is evident that the skulls of definitely low types of mankind can frequently exhibit a horizontal circumference equal to the average European, and it teaches us one instructive fact, namely, that the increased cranial capacity of white races is due for the most part to an expansion upwards of the roof of the skull above the level of a horizontal plane passing through the glabella and the occipital point.

The Cranial Measurements.

	No. 1 Skull	No. 2 Skull
Cranial length (Glabella-inion)	19.00 cm.	19.9 cm.
Cranial breadth	12.20 cm.	12.80 cm.
Basal height of cranium	12.95 cm.	13.05 cm.
Horizontal circumference	52.07 cm.	53.49 cm.
Nasion to Basion	9.75 cm.	9.65 cm.
Basion to Alveolar Point	9.95 cm.	10.30 cm.
Nasal height	5.45 cm.	5.10 cm.
Nasal breadth	2.75 cm.	2.80 cm.
Bizygomatic breadth	14.35 cm.	13.90 cm.
Interstephanic breadth	10.50 cm.	10.00 cm.
Orbital breadth	4.15 cm.	4.10 cm.
Orbital height	3.35 cm.	3.35 cm.
Palatomaxillary length	5.50 cm.	5.85 cm.
Palatomaxillary breadth	6.35 cm.	6.55 cm.
Minimum post-frontal breadth	9.50 cm.	9.30 cm.
Glabella-bregma chord	11.15 cm.	11.35 cm.
Bregma-lambda chord	12.10 cm.	12.35 cm.
Lambda-inion chord	6.60 cm.	6.45 cm.
Maximum distance of frontal arc from chord	13.5 mm.	14.0 mm.
Maximum distance of parietal arc from chord	30.0 mm.	34.0 mm.
Maximum distance of lambda-inion arc from chord	9.0 mm.	9.0 mm.

The Cranial Indices and Angles.

	No. 1 Skull	No. 2 Skull
Spheno-maxillary angle........	95.	97
Cephalic index................	64.21	64.32
Index of height...............	68.15	65.57
Nasal index...................	50.4	54.9
Alveolar index................	102.05	106.7
Stephano-zygomatic index......	73.17	71.9
Orbital index.................	80.7	81.7
Facial index..................	50.5	54.6
Palato-maxillary index........	115.4	111.9
Fronto-parietal index.........	77.8	72.6
Calvarial height index........	58.4	55.7
Bregmatic angle...............	59.	55
Spheno-ethmoidal angle	151.	151
Foramino-basal angle..........	146.5	148

The Cephalic Index.—The cephalic index was 64.21 for No. 1 Skull and 64.32 in the case of No. 2. They were thus shown to be extreme examples of dolichocephaly, which is the usual condition met with in Melanesian skulls(12). Of course such an excessive dolichocephalic condition may be explained partly at least by the fact that in the island of South Malekula, from which these skulls were obtained, the natives, as Dr. Annand states, deliberately apply bandages in infancy in order to produce long heads. The above indices closely approximate to the lowest recorded cephalic index the writer can find a reference to, namely, 61.9 which was found by Sir Wm. Flower(13) in a Fiji islander. It may be mentioned here that the inhabitants of the latter group of islands are also definitely Melanesian, and exhibit the lowest average cephalic index of any tribe or race, namely, 66(14).

It is important to emphasise the fact that the cephalic index taken by itself is no criterion of intellectual capacity. It is true that in the more darkly colored races of mankind, including those with the most primitive type of brain, doli-

chocephaly is the predominant form of skull and it is the condition met with in certain extinct races of mankind, such as Neanderthal or Mousterian man (cephalic index 73.9),[15] and Cro-magnon man (cephalic index 73.3)[16]. The average cephalic index for the Anglo-saxon race is 76.1,[17] which is usually classed as mesaticephalic. The index for the British skull, however, so closely approaches the transition point into dolichocephaly which is 75, that many anthropologists place it in a special class termed subdolichocephalic.[18] Yet who of us will admit for one moment that the Briton is inferior to any race in either intellectual capacity or ability. Just to illustrate further how much the cephalic index fluctuates, one has only to study it amongst the anthropoid apes, where the gorilla, the most highly evolved of them, is dolichocephalic, the chipmanzee is mesaticephalic and the orang-utan is brachycephalic.[19]

It is of interest to find that the average cephalic index of the Polynesian skull is about 80,[20] and therefore tends to belong very definitely to the brachycephalic group. It is thus a somewhat striking fact to note that the inhabitants of even neighbouring groups of islands can exhibit a very distinct contrast in regard to their cephalic indices.

The Index of Cranial Height.—The index of height was calculated to be 68 in No. 1 skull, and as low as 65.6 in No. 2. These represent the lowest indices I have been able to find a definite record of. These skulls may be thus placed at the lowest limit of the tapeinocephalic class. They are decidedly lower than the height index even of the aboriginal Australian skull which averages about 71,[21] and also lower than the Fijian average 74,[22] which may be taken as a representative Melanesian type. In the case of this index the effect of binding the head would again certainly have to be considered, and may, indeed, account in great measure for the above remarkably low indices. It may perhaps be as well to note at this point that the bandaging does not appear to

have produced any freak effects in the case of the other cranial indices.

The Nasal Index.—The study of the nasal index yielded some interesting results. Some anthropologists emphasise very strongly the importance of this index as a criterion of racial origin. It is found that the lower the type of cranium the higher is this index. That is to say, the nasal aperture of the skull is broadest in the lower races. Applying this idea to the two skulls in question it was found that the nasal index in No. 1 skull was 50.4, and in No. 2 as high as 54.9. Thus the latter was definitely platyrrhine, being above 53, and the other almost leptorrhine. Another significant fact to be recorded was that the index in No. 2 skull practically corresponded to the Melanesian average of 55,(23) whilst the other approximted to the Polynesian index of 48.(24) Thus the nasal index, taken in conjunction with the cephalic index and the index of height, again demonstrates the marked racial inferiority of No. 2 skull, and certainly suggests that there must be a strong admixture of Melanesian and Polynesian types in the New Hebrides. It is rather remarkable that two skulls collected at random should indicate such marked racial differences.

The Alveolar or Gnathic Index.—The alveolar index proved to be even more significant than the preceding; for in No. 1 skull it was found to be 102, while in No. 2 it reached the high figure of 106.7. The latter represents the most extreme condition of prognathism the writer has ever met with. It certainly greatly exceeds the average of the aboriginal Australian of today which is supposed to represent the lowest type of skull extant, and is, according to Flower, 104,(25) though some anthropologists do not place it so high as that. For example Duckworth(26) gives it as 101.1. In any case an investigation of the alveolar index of these two skulls indicated that both were of the Melanesian type, though No. 1 approximated to the Polynesian average index

of 98.6 whilst No. 2 was shown to be pronouncedly Melanesian.

The Stephano-zygomatic Index.—The stephano-zygomatic index was found to present some features of striking interest. In No. 1 skull it was 73.17 and in No. 2, 71.9. Both were evidently at the lowest level for this index in man and were thus markedly phaenozygous, No. 2, as usual, representing the lower type. Compare these results with the index of 90.7 found in the adult European male or the 94.6 of the European female.[27] It is of interest to note that this index may rise as high as 116 in the infant skull of white races, which is thus remarkably cryptozygous. In the gorilla this index goes down to zero owing to the meeting of the temporal lines to form the prominent median crest along the line of the sagittal suture.

The Orbital Index.—There has been much discussion among anthropologists regarding the value and significance of the orbital index, many having seriously challenged its general utility as an indication of race. It certainly shows a wide range of variation not only throughout the hominidæ, but also in persons belonging to the same race. This fact is well exemplified in these two skulls, for No. 2 which in the case of the previously recorded indices has consistently shown an inferior degree, is in a slightly elevated position to No. 1 in regard to the orbital index, the figures being respectively 81.7 and 80.7. They both, however, exhibit a definitely low type, being markedly microsemic, though they do not reach the low ebb indicated by 75,[28] as found in certain aboriginal Tasmanian skulls. In Polynesians, on the other hand, as in all mongoloid races, this index is remarkably high, being usually above 89[29]. They are therefore classed as megasemic. However variable the orbital index may be, it certainly indicates to us that the vertical dimensions of the orbital aperture are greatest in the mongoloid races and least in the aboriginal Australians and Melanesians,[30] with

the European races occupying an intermediate position. Now it is a very significant fact that the frontal air sinuses and also the superciliary ridges are relatively large in the lowest types of modern hominidæ, and I hope to be able to prove that the greatest influence on the modelling of the orbital contour is exerted by the degree of development of the air sinuses of the skull. A remarkable feature of the orbital index is that it is consistently higher in the female skull of any given race.[(31)] Surely this supports the statement just made; for it is well known that the frontal sinuses and the superciliary ridges are always better developed in the male than in the female. Another significant fact is that the orbital index is always relatively high in the infant, in whom it is to be again noted the superciliary ridges are not yet developed, seeing that the frontal sinuses do not begin to make their appearance until after infancy. As a result of these observations it appears to the writer that the orbital index deserves a more prominent position in physical anthropology than that accorded to it by some investigators on the subject.

The shape of the orbital margin has also been neglected somewhat by anthropologists. The general impression I have gained from a study of it is, that in the higher types of skull the opening is rounded in character, while in the lowest types (aboriginal Australians for example) the outline tends to be somewhat quadrangular, owing apparently to a flattening of the upper and lower margins. The writer's attention was first directed to the orbital contour in 1908, when studying the skulls belonging to two ancient Egyptian skeletons of the XIIth dynasty. One of these was of a highly evolved orthognathous type, all its indices actually comparing favourably with those of the modern European skull. The other was of a distinctly lower order, some of its indices being distinctly negroid in character. For example, the alveolar index was 104.3. These two mummies, according to the heiroglyphs on their coffins were brothers and a full

discussion of their supposed ancestry will be found in the memoir(32) dealing with them. One of the most striking points of difference in these two ancient Egyptian skulls was the shape of the orbital margins. In the finely modelled orthognathous skull, with small frontal sinuses, these were decidedly rounded or circular in character, with the high orbital index of 92.6, in fact the highest I have ever found. In the second or negroid type of skull, which exhibited relatively large frontal sinuses and prominent superciliary ridges, the orbital margins had the peculiar quadrangular outline noted above, with the relatively low index of 82. On pursuing the investigation further, I found that this quadrangular contour was best marked in low types of skulls, being particularly well exhibited in the aboriginal Australian and Melanesian types. It is clearly shown in the two New Hebridean skulls, and this feature would place them definitely in the Melanesian group. The next point to be determined is, "What is the causation of this characteristic outline in low types of skulls?" The suggestion I would offer is, that the excessive development of the frontal air sinuses and the maxillary sinuses that one finds in these skulls has the effect of producing a flattening of the upper and lower orbital margins, owing to the encroachment of the expanding bone upon them, thus lowering the orbital index, and at the same time imparting the quadrangular contour. There can be no doubt that the degree and direction of development of the air sinuses of the skull must exert a profound effect upon its architecture and general configuration.(33)

The Facial Index.—The facial index was found to be 50.5 in No. 1 skull and 54.6 in No. 2. They were both above 50 and were thus to be classed as dolichofacial, as one would be led to expect in two skulls which were so pronouncedly dolichocephalic, seeing that long headed skulls are also usually long faced, though this is by no means a constantly concomitant occurrence.

The Fronto-parietal Index.—This index is one that has not received the attention it deserves from anthropologists and evolutionists. Indeed it is only during recent years that its importance and significance have been really appreciated. So far as the bibliography at my disposal indicates, Schwalbe(34) appears to have been one of the pioneers in exploiting its application to craniometry, for he makes full use of it in his classic memoir on the Neanderthal skull, though he takes care to emphasise the fact that the index is not always an infallible means of demarcating the anthropoid apes from examples of fossil hominidæ such as the Neanderthal specimen, For example, the fronto-parietal index of the Krapina skull which represents a type of Neanderthal or Mousterian man, has been calculated by Kramberger(35) to be 64.7, this being actually less than that of the skull of the Java man-ape, which works out at 65.4.(36) Figure 1 is an outline of the skull of the Java man-ape viewed from above and drawn to scale. It shows how intense is the degree of post-frontal constriction which, according to the index, is 65.4% of the maximum parietal breadth. For purposes of comparison, the outline of No. 2 skull seen from above is shown in Figure 1, which is also drawn to the same scale. The fronto-parietal index of No. 2 skull was as low as 72.6, that is to say, it was actually less than that of the Neanderthal skull (see Figure 2) which has been calculated as 73.1, and was much below the average index for the aboriginal Australian of to-day which has been given as 77.(37) The corresponding index in No. 1 skull, as was to be expected, was decidedly higher than that of No. 2, namely 77.8, and, as would be noted, a little above the aboriginal Australian average. Another important point emphasised in Fig. 1 is the marked phaenozygous condition exhibited by No. 2 skull.

The Calvarial Height Index.—This is another cranial index

which has secured the attention it deserves only within recent years. It is essentially a study of the degree of flattening of the cranial roof, and would therefore naturally be expected to yield most striking results. The index is usually taken as the proportion which the maximum height of the calvaria bears to the glabella-inion length (the line GI in Fig. 4). In this Figure the calvarial height is the greatest distance to the cranial roof measured perpendicularly from the line GI. The index of calvarial height was found to be 58.4 for No. 1 skull and 55.7 for No. 2. These results when interpreted showed of course that the calvarial height of both was slightly more than half the maximum cranial length. In the skulls of the higher races of mankind this index is, of course, always well over fifty. It is interesting to compare this with the extreme degree of flattening of the cranial roof of the Java man-ape, represented by an index of 34.3,[38] and the flattening of the cranial arc in the Neanderthal skull, represented by an index of 40.4[39]. Figure 4 has been designed for the purpose of still further emphasising the importance of this index. The curves represent the antero-posterior outlines of the roofs of four skulls in the sagittal plane. The line GI is the glabella-inion length and from it the calvarial height was measured. The horizontal planes of the skulls, are only approximately denoted for all four, as an average had to be taken. The cranial curves are all drawn to scale. The lowest curve indicates the outline of the cranial arc of the Java man-ape. The upper two cranial arcs become very definitely separated, in front, the lower of the two indicating an outline of the frontal part of the roof of No. (1) skull, while the upper is that of an average Canadian skull taken at random for purposes of comparison. The Figure demonstrates wha an enormous degree of expansion the cranial roof has under gone since the evolutionary stage represented by the Java man-ape, and, indeed, makes one seriously question whether

the latter ought really to be regarded as an ancestral type. The calvarial height in both No. 1 and No. 2 skulls, as Fig. 4 shows, was found to be as great as that of a Canadian skull. Therefore what might not inaptly be termed the intellectual expansion of the skull of the higher races has been practically confined to the frontal segment of the cranial arc. This conclusion certainly supports the current idea that the higher intellectual centres of the brain are mainly centered in the frontal lobes.

The Palato-maxillary Index.—The palato-maxillary index was 115.4 in No. 1 skull which therefore proved to be brachyuranic. In No. 2 it was found to be 111.9 thus classing this skull as mesuranic. The palate in No. 1 skull was therefore relatively broader than that of No. 2, though not absolutely so, seeing that its measurement was 6.35 cm., that of No. 2 being 6.55 cm. The importance and significance of this index have not been worked out yet with any degree of certainty, so that it will be sufficient to place the above measurements on record for future reference and comparison.

The Bregmatic Angle.—This is an angular cranial measurement which has likewise come to assume a position full of importance and significance only within comparatively recent years. It demonstrates in a very effective and telling manner, the degree of flattening or otherwise of the frontal portion of the cranial arc. As it is not mentioned much in books, and as there appears to be some ambiguity regarding its exact mode of application, and method of measurement, I may state that I adopted the plan utilised by Schwalbe(10) in his study of the Neanderthal skull. He took the angle between two lines, one passing from the glabella to the inion, and the other from the glabella to the bregma, as shown in Figure 6, where the line IG is the occipito-glabellar, and BG the bregma-glabellar. The bregmatic angle was found to be 59° in No. 1 skull, and 55° in No. 2. These results were thus well within the range of variation for modern hominidæ,

which is given by Duckworth[41] as from 53° to 66°, and their average closely corresponded to that of 56° found by Berry and Robertson[42] as the result of examining forty-five aboriginal Tasmanian skulls, and is, on the other hand, slightly higher than the average of 54.7° found by the same two observers,[43] after investigating the bregmatic angle in a series of one hundred aboriginal Australian skulls. It is significant to note once more, that No. 1 skull, as usual, exhibits a definitely superior type of index. Indeed, it is a rather fortuitous circumstance that these two Melanesian skulls, which were obtained in quite a random way, should have consistently shown approximations to the maximum and minimum limits, respectively, in the range of variation of their cranial indices with one exception, the orbital, which recorded practically the same result in both. This all goes to show how mixed is the race that inhabits the New Hebridean group of islands, the admixture of a higher grade Polynesian strain being, no doubt, the cause of this wide range of difference. An examination of two skulls thus proved sufficient to substantiate the statement in Dr. Annand's letter regarding this fact, but of course the writer knows and recognises the necessity for an investigation extending over hundreds or even thousands of crania in order to secure analytical results that would adequately satisfy anthropologists on this matter.

The Glabella-Bregma Chord and the Curvature of the Frontal Cranial Arc.—The glabella-bregma chord was estimated to be 11.15 cm. in No. 1 skull and 11.35 cm. in No. 2, results which correspond very closely with those of Berry and Robertson[44] who record 11.08 cm. as the average for one hundred aboriginal Australian skulls, and 10.95 cm. as the average result in the case of fifty aboriginal Tasmanian skulls. It may be of interest to mention also that the glabella-bregma chord in the Spy-Neanderthal race measured about 11 cm. on the average, while the writer calculated that it was 11.13 cm. in Smith Woodward's reconstruction of

the Piltdown skull. It is evident then that the length of the glabella-bregma chord exhibits no very striking points of significance, as it is apparently a fairly constant factor both in fossil and in modern hominidæ. It is a very different story, however, with regard to the maximum distance between it and the frontal cranial arc. This was calculated to be 13.5 mm. (at a point about midway between the glabella and the bregma) in No. 1 skull, and 14 mm. (at a point about two thirds of the way from the glabella to the bregma) in No. 2 skull, distances which compared in the most striking degree with 25 mm., which the writer found in the case of a Canadian skull taken at random(this, it may be mentioned, is a medium figure for the skulls of white races). Figure 6 has been designed to demonstrate the fact that the evolution of the frontal cranial arc is due in least degree to the elongation of the glabella-bregma chord, and in very marked degree to the expansion of the Bregmatic angle and the increase in the curvature of the frontal cranial arc. It may be mentioned that the writer calculated the maximum distance of the frontal cranial arc from the glabella-bregma chord to be 25 mm. in Smith Woodward's reconstruction of the Piltdown skull, which was thus nearly twice that in these two Melanesian specimens. In fact the latter were to be intimately compared to such lowly evolved skulls as those of the Spy-Neanderthal race where the above average distance was found to be 14.3 mm.[(45)]

The Bregma-lambda Chord and the Parietal Arc.—The bregma-lambda chord was 12.1 cm. in length in No. 1 skull and 12.35 cm. in No. 2, measurements which are both slightly higher than the average for one hundred aboriginal Australian skulls, which was found by Berry and Robertson[(46)] to be 11.46 cm., and likewise higher than the average for forty-eight aboriginal Tasmanian skulls which was calculated by the same two observers[(46)] to be 11.3 cm. The maximum distance of the chord from the parietal arc was 30 mm. in

No. 1 skull and 43 mm. in the case of No. 2. These are excessively high figures when compared with the measurements found by Buchner[46] in aboriginal Australian and Tasmanian skulls which were 23.2 mm. and 23.3 mm. respectively. This intense degree of curvature of the parietal arc imparted an extraordinary appearance to these two New Hebridean skulls, when studied in mesial section, the arching of the vault in both being very abrupt and sudden indeed in this region.

The Lambda-inion Chord and Arc.—The lambda-inion chord was 66 mm. long in No. 1 skull and 64.5 mm. in No. 2, measurements which, like the parietal chord, are very much above the averages for aboriginal Australian and Tasmanian skulls, given by Buchner[46] as 55.2 and 55.5 respectively. The maximum distance of the chord from the arc was the same for both No. 1 and No. 2 skulls, namely 9 mm. This was likewise very decidedly above the average of 6.1 mm. found by Buchner[46] in aboriginal Australian and Tasmanian skulls.

The Spheno-maxillary Angle.—This angle constitutes a useful and at the same time fairly constant index of the degree of prognathism, and is in many ways preferable to Camper's facial angle and the Frankfort facial angle. It therefore proved to be a most valuable cranial measurement in the case of these two skulls. It was found to be 95° in No. 1 and 97° in No. 2 skull, figures which closely approximated tc Huxley's results in a Melanesian skull, viz. 99°. It should be noted, however, that Huxley[47] who initiated the use of this angle in the course of his researches on the cranio-facial axis utilised the akanthion as his anterior point, while I employed the prosthion.[47] This may account for the slight difference in the results. These figures contrast very strongly with 75° which was the average result obtained by Duckworth[47] in the measurements of two European skulls and the angles calculated by the same observer in

orang-utan and gorilla skulls which were 145° and 125° respectively. It is quite obvious, then, that as regards prognathism, these two New Hebridean skulls are definitely situated in a position intermediate between the anthropoid skull and that of modern white races.

The Spheno-ethmoidal Angle.—This is another useful angular cranial measurement, the condition of which in these two skulls is well worth recording. It, like the spheno-maxillary angle, was apparently first employed by Huxley,[17] and is therefore usually associated with his name. It really yields quite instructive results, for it shows us how much the cranio-facial axis has become bent upon itself during the evolution of the skull. For example, if one studies a mesial section of the skull of an anthropoid ape, like the orang-utan, it will be noticed that the cribriform plate of the ethmoid, the body of the sphenoid and basilar portion of the occipital bone are practically in the same straight line, thus placing the spheno-ethmoidal angle somewhere in the vicinity of 180° in the apes. As a matter of fact it may be a little above or below this figure. On examining a mesial section of the modern human skull it will be noticed that a profound alteration has taken place, for while the cribriform plate of the ethmoid has remained practically horizontal, the sphenoid and occipital bones have been very definitely forced downwards, thus reducing the size of the angle. It will therefore be recognised that the higher the type of skull, the smaller is the size of this angle. The spheno-ethmoidal angle was found to be the same in both of these New Hebridean skulls, namely 151°, which closely approximates to the figure of 153°, found by Duckworth[17] in the case of two aboriginal Australian skulls. The same observer[17] gives 138° as the average result in two European skulls, so that evidently there is a substantial difference between the size of the angle in the highest and lowest races of modern mankind.

The Foramino-basal Angle.—This angular cranial measurement is usually associated with the name of Sir William Turner[47] who made extensive use of it in measuring the Challenger collection of skulls. It was found to be 146.5° in No. 1 skull and 148° in No. 2. This closely approximates to the figure of 147° which was estimated by Huxley[47] in a Melanesian skull. Duckworth[47] gives 149° 30′ as the average size of this angle in two European skulls. It is evident therefore that the size of the foramino-basal angle varies very slightly throughout all types of modern hominidæ. Indeed its range of variation is so small that it cannot by itself be utilised as a determining factor in a comparative study of the human race. It is very serviceable however in comparing the skull of man with that of lower animals, where it appears to become consistently smaller the further down the Mammalian series one goes. This profound alteration is due to the fact that the foramen magnum which in man lies practically in a horizontal plane, comes to look more and more backwards as one descends the animal scale. For example Duckworth[47] records a foramino-basal angle of 120° in the gorilla and one of 108° in the dog.

Some Additional Features of the Two Skulls.—No. 1 skull was remarkably thin, the upper part of the frontal bone being only 4.5 mm. in thickness. No. 2 skull, on the other hand possessed a thickness twice as great on the average as that of No. 1. The lower parts of the temporal fossæ in both skulls were remarkably capacious, the distance be-between the inner surface of the xygoma and the bottom of the fossa being as much as 25.5 mm. in No. 2 skull and 24 mm. in No. 1. These large gaps indicated of course that the temporal muscles had been very powerfully developed, as one would have expected in a race addicted to cannibalism and unconventional mastication. The various air sinuses were remarkably large. Those in the frontal bone were very spacious, their influence in producing the excessively

prominent superciliary ridges being very well demonstrated in mesial sections of the skulls. The sutures were arranged on a very simple plan, there being few of the elaborate sinuosities encountered in the skulls of white races. No suggestion of metopism was to be detected in either skull. There was a fronto-squamous suture at the pterion on the right side in No. 1 skull. The styloid processes were remarkably short as in aboriginal Australian skulls, but the anomalies so frequently found in that race in the region of the foramen magnum were not present. Prenasal grooves were marked features of both skulls thus rendering the lower margins of the nasal apertures very indistinct in appearance. The nasal bones met at an obtuse angle, a condition which is in striking contrast to Polynesian skulls where the union occurs at an acute angle.

The Dentition.

The teeth were markedly worn in No. 1 skull and very slightly so in No. 2, from which fact one may safely gather that No. 1 skull had belonged to a somewhat older individual, a conclusion which was confirmed by an examination of the degree of synostosis of the sutures as stated on page 407. In the case of No. 1 skull it was noticed that the right molars were much more worn than those of the left side. On showing this condition to my colleague, Dr. Frank Woodbury, he at once pointed out the cause, which was a pyorrhoea alveolaris round the first left molar of the upper jaw, which had loosened the fangs of that tooth and no doubt made it very tender on pressure. The alveoli of this tooth were almost obliterated by the disease, and the tooth itself was missing from the skull.

The upper central incisors in both skulls had been lost, probably during the period of inhumation, but were replaced by neatly modelled wooden pegs, made as far as possible of the size and shape of the missing teeth. These were apparently put in to form a background against which the lips

of the facial masks could be more accurately moulded into shape. It required a close inspection of these pegs to convince oneself that they were not the actual teeth and their true character was only found out by accident when one of them happened to drop out of its socket one day.

The dental index could not be calculated for No. 1 skull, as the 3rd molars had never developed in either jaw. In the case of No. 2 skull it proved to be 41.9 which placed it definitely in the microdont class. This disclosed a very anomalous condition, since the index for Melanesians is usually above 44, thus placing that race in the megadont class. This conclusion was supported by an examination of the molar teeth.

In No. 1 skull the number of molar cusps was as follows:

	Upper Jaw	Lower Jaw
1st Molar.....	4 cusps	5 cusps
2nd Molar.....	4 cusps	4 cusps
3rd Molar.....	not developed	not developed

In No. 2 skull the number of molar cusps was as follows:

	Upper Jaw	Lower Jaw
1st Molar.....	4 cusps	5 cusps
2nd Molar.....	4 cusps	4 cusps
3rd Molar.....	3 cusps	4 cusps.

The third upper molars in No. 2 skull only showed three cusps, due, as was to be expected, to the loss of the hypocone, thus showing a tendency to trituberculism. Indeed, the molar teeth in both skulls exhibited this tendency to a reduction in the number of cusps, an interesting condition, especially when one considers the primitive race to which they belonged. For example, the 1st molars of the lower jaws were the only teeth that showed five cusps, while in one case the 3rd molars had not even been developed in either jaw. It is thus a notable fact that in these two low grade skulls the upper molar teeth were found to be in process of transition into the

three cusped type, and the lower molars from the five cusped into the four cusped pattern; and demonstrates very definitely that this reduction process is by no means confined to the higher races of mankind.

In regard to the size of the molar teeth, it was noted that in No. 1 skull the 2nd upper molars were definitely smaller than the 1st, while the 2nd lower molars were a very slight degree smaller than the 1st. In the case of No. 2 skull, the 3rd upper mollars were distinctly smaller than the 2nd molars, while the 3rd lower molars were practically of the same size as the 2nd and both were smaller than the 1st, on each side of the jaw. It will be noted from what has been stated that the dentition was somewhat anomalous in these skulls and may explain why the lower jaws displayed so little evidence of prognathism. Some anthropologists, amongst whom may be specially mentioned Sir. W. Flower, have laid great emphasis on the comparative study of the molar teeth. He showed that they tended to be larger in the primitive races, where they may occupy in the dental arches relatively the same compass as in an anthropoid ape like the chimpanzee. Moreover in these lower races the 2nd and 3rd molars tend to approximate to the size of the first, thus showing a reversion to primitive ancestral types. For example, in the lower jaw of the chimpanzee the three molars are all of the same size. In the jaw of Heidelberg man, who stands at a very low level in the human family tree, the three molars are again found to be all practically of the same size. In Neanderthal or Mousterian man, who was also closely allied to Heidelberg man, the 2nd and 3rd molars were as large as the first. The 2nd molar of the Piltdown man was slightly smaller than the first. His 3rd molar was never discovered. In the upper and lower jaws of No. 1 skull the 2nd and 3rd molar teeth were likewise certainly smaller than the 1st. Note further that in the jaws of the chimpanzee, Heidelberg man, and

Piltdown man, the front teeth have plenty of accommodation in the alveolar arch, a condition which, it may be noted, is associated in all three examples with the absence of a chin. In modern man, on the other hand, the chin has developed and the teeth have become closely packed together, thus threatening to crowd out the 3rd molars altogether, a condition which is certainly going on in the upper jaw as well as the lower, especially in the higher races of modern mankind. It may further be asked, "Are the reduction of the dental arch and the evolution of the chin to be regarded as two closely associated phenomena?" A study of man's ancestry would certainly appear to suggest this fact.

In confirmation, as it were, of the superior type of dentition in these two New Hebrides skulls, the upper alveolar arches in both do not show the U shape which is the usual condition in a low race like the Melanesians, but the parabola-like curve of the arch that is found in the higher races of mankind. I am bound to say that the dentition and the modelling of the jaws of these two New Hebrides skulls show some very anomalous features which appear worthy of being placed on record.

The Facial Masks.

The facial masks were of a peculiar iron-rust tint with coloured decorations superadded. Their outline in both cases followed the lower borders of the mandibles and extended upwards from this along the posterior edges of the rami and crossed the roots of the zygomatic arches just in front of the external auditory meatuses. They covered the lower parts of the temples. The upper edges swept across to the opposite side along the line of what would have been the junction of the forehead with the roots of the hair. They were thus strictly limited to the facial portions of the skulls. In one case the posterior edge had attached to it a model of the front margin of the external ear. This fact suggests that the clay masks may have covered the whole skull at

one time, but the line of demarcation is so definite in both cases that I am inclined to believe they never at any time covered more than the faces.

The brow of each mask is rather finely modelled, the arching eyebrows being very well worked out. They do not show any bulging to represent the prominence of the superciliary ridges, though the latter are well marked in the skulls. The aperture of the eye is rather small in both masks, and its long axis is set obliquely, though this axis is inclined downwards and outwards instead of upwards and outwards as in the Mongolian type of face.

The nose in No. 1 mask tends to be of the European, or, at any rate, Polynesian type. It is sharp and straight in outline with the exception of a light bump at the junction of the nasal bones with the cartilaginous portion, which is of course a common feature of the nose of white races. On the whole, it is moulded on rather fine lines, if one may except an increased roominess of the nasal apertures, and a slightly greater width between the alae, when compared with the average European type. The nose of No. 2 mask shows more of the negroid type, for it is slightly concave from above downwards, and is wider and flatter than that of No. 1. Moreover, the alæ are also larger, and the capacity of the nasal apertures greater. This fact is of interest when compared with the persistently lower cranial indices of No. 2 skull as compared with No. 1.

The ridge of the nose when examined in profile is, in both masks, almost exactly in line with the backward slope of the forehead thus emphasising the latter to a marked degree (Figure 9).

The cheeks of both masks are rather prominent, this effect being exaggerated by a marked hollowing of the lower parts of each. The mouth in both instances is much larger than in the European type of countenance. The lips are, however, not of the thickened negroid type; in fact they are

very neatly modelled; but they are strongly everted, an arrangement which gives the mouth a half open appearance. The chin and the lower part of the face generally are in both masks modelled on rather attractive lines.

The Decorations on the Masks.—The decorations on No. 1 mask consist of a circular target-like design, painted on each cheek, on the centre of the forehead, and on the chin. The circle on each cheek is better preserved than the others. It is 45 mm. in diameter and consists of an outer ring 10 mm. in width painted white. The inner circle demarcated in this way is 25 mm. in diameter, and painted a pale pink. This had become somewhat faded but was apparently the colour adopted for all the inner circles.

The circle on the brow is 36 mm. in diameter, and consists of an outer belt of white 10 mm. in width enclosing an inner circle, painted pale pink, 16 mm. in diameter.

The circle on the chin extends from the edge of the lower lip to the tip of the chin. It is 31 mm. in diameter, and is surrounded as usual by a white band 10 mm. in width enclosing an inner pale pink central portion 11 mm. in diameter.

The scheme of decoration adopted for No. 2 mask is rather peculiar and striking. The outer portions are entirely coloured a pale blue, reminding the writer strongly of the blue clay with which housewives in Scotland, especially in fishing villages of the east coast, are so fond of decorating their door steps and window ledges. The line of demarcation of this outer blue area from the iron-rust brown coloured part of the mask is very sharply defined, and runs symmetrically in a downward and inward direction on the forehead towards the root of the nose, where the two edges are separated merely by a gap of 9 mm. From this point the lines follow the lateral margins of the nose, thus mapping it out very definitely from the rest of the mask. The lines then run downwards just clear of the angles of the mouth,

from which they are continued downward and very slightly inward to the lower edge of the mask, where they are separated by a distance of 9.1 c. m. measured over the tip of the chin.

The question of the meaning and significance of these masks provides much material for thought and reflection. I can find no reference to them in "The Life of Dr. John Geddie," which otherwise gives an elaborate account of the habits, customs, beliefs, and superstitions of the inhabitants of the New Hebrides.[15] Dr. Annand in his letter (see page 405) mentions that in some Islands the body is encased in clay immediately after death. In the case of these skulls, however, it is quite evident that the masks had been moulded directly on the bone surface, which meant that the skulls had probably lain in the earth for years. They certainly look as if they had been inhumed for a prolonged period of time, and this theory is supported by the loss of several of the teeth from both skulls, their sockets being left intact. Besides, the cocoanut fibre which formed the background of the masks is tucked under the zygomatic arches and into the orbits, while a plug exactly fits the anterior nasal aperture of both the skulls. A few dried shreds representing decayed scalp could be noted adhering to the parietal and occipital regions of No. 2 skull.

The first point that strikes one on studying the decorations on the mask of No. 1 skull is their resemblance in some ways, to the circular design found tattooed on the foreheads, cheeks, and chins of Maori chiefs nowadays. The Maoris, it may be noted, are Polynesians. The heads of many of these great chiefs were afterwards embalmed and carefully preserved as relics. With the knowledge of this Polynesian custom in one's mind it was certainly remarkable to find that No. 1 skull which possessed definite Melanesian cranial indices was provided with a clay mask exhibiting Polynesian facial features, and decorated in a style also suggesting Polynesian influence and inspiration. It is possible then,

that No. 1 skull was that of a prominent chief, whose countenance, it was arranged, should be immortalised in clay many years after his death. This theory is strengthened by the fact that the bodies of the common people in the New Hebrides were usually thrown into the sea, a fact which is mentioned in Dr. Annand's letter (see page 405) and also in the life of Dr. John Geddie.

The writer was able to glean much suggestive information bearing upon these skulls from the extensive writings of Sir J. G. Frazer, and was particularly impressed by the following remarks(49) regarding the customs of the inhabitants of New Guinea, who it may be mentioned, are usually classed as Melanesians: "The preservation of the skulls and bones of chiefs and other noteables for years . . . must apparently be designed to propitiate or influence in some way the ghosts of the persons to whom the skulls and bones belonged in their lifetime." Again, in another of his works,(50) the same authority makes the significant statement that the head of a chief is held in the greatest sanctity throughout Polynesia. It was no doubt this fact which inspired the idea of preserving his head and features as a possible means of protection against misfortune and the influences of evil.

The moulding of the facial features in No. 1 skull, and the subsequent decorative scheme certainly suggests to the writer that some Polynesian influence was at work here.

On now studying the condition in No. 2 skull, it will be noted that this showed extreme Melanesian cranial indices, while the moulding of the facial features was also undoubtedly Melanesian. The decoration also shows a marked difference from that in No. 1, there being no suggestion of the characteristic circular design. Professor Falconer of Pine Hill College very kindly showed me an elaborately painted wooden god from the New Hebrides which seemed to offer a clue to this style of decoration, for on the right half of the forehead and on the left cheek were patches of blue of exactly the same

tint and apparently the same chemical nature as that in No. 2 mask. Certainly the study of these masks is pregnant with suggestion, and as I am unable at present to find any references to ethnological literature dealing with these, I am publishing my own personal impressions in order that they may inspire some controversial discussion on the subject.

Professor E. Mackay of Dalhousie University has very kindly made a chemical examination of the material constituting the facial masks, and he reports that the vegetable fibre which forms a sort of basis "is cemented together by material which is very largely organic, containing a small amount of ochre-like substance which is chiefly an oxide of iron."

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4. See the extensive memoir by de Quatrefages, *Races Humaines*, 1889.
5. *Polynesian Researches*, W. Ellis, 1831.
6. *Origin of the Polynesian Nations*, C. Fornander, 1885.
7. *Polynesian Mythology and Maori Legends*, 1885.
8. *Catalogue of the Museum of the Royal College of Surgeons of England*, London, 1879.
9. *Morphology and Anthropology*, 1904.
10. *Reports of the Voyage of H. M. S. Challenger, 1880-1895, Vol. X, Zoology.*
11. *Quain's Anatomy, 10th Edition.*
12. Broca placed them in the first of his five great divisions, *Revised Anthrop*, 1872.
13. *Jour. Anthrop. Institute*, 1880.

14, 21 and 22. Sir Wm. Flower, *Catalogue of the Museum of the Royal College of Surgeons of England, London, 2nd Ed.*, 1879, 1907.

15. *Der Neanderthalschadel*, Bonner Jahrbucher, Heft 106, 1901.
16. *Reliquiæ Aquitanicæ*, Lartet and Christy, 1865-1875.

17 and 18. P. P. Broca in *Revue d'Anthrop.*, 1872.

19 and 20. *Morphology and Anthropology*, W. L. H. Duckworth, 1904,

23, 24 and 26. *Morphology and Anthropology*, 1904.

25. *Catalogue of the Museum of the Royal College of Surgeons of England*, London, 1879.
27. From Topinard's *Elements d'Anthropologie generale.*

28 and 29. *L'Indice Orbitaire*, P. P. Broca, 1876.

30. It should be mentioned that Sir Wm. Flower (*op. cit.*) found this index as low as 80. in the aboriginal Guanchos of the Canary Islands.
31. Froriep, *Archiv fur Anthropologie*, 1902.
32. *Manchester University Museum Publication No. 63*, 1910.
33. This is to form the subject of a future publication.
34. *Der Neanderthalschadel*, Bonner, Jahrbucher, Heft, 106, 1901.
35. *Mittheilungen der anthropologischen Gesellschaft in Wien, Bd. 32.*

36 and 37. Quoted by Duckworth, *Morphology and Anthropology*, 1904.

38. Schwalbe, Zeitschrift fur Morph. und Anthrop. Bd. 1, 1899.
39. Schwalbe, *op. cit.*

40 and 41. *Op. cit.*

42. *Proc. Roy. Soc. Edin.*, Vol. XXXI, Pt. I, 1910-11.
43. *Proc. Roy. Soc. Edin.*, Vol. XXXIV, Pt. II, 1913-14.
44. *Op. cit.*
45. Quoted by *Buchner, Proc. Roy. Soc. of Edin.*, Vol. XXXIV, Pt. II, 1913-14.
46. *Op. cit.*
47. *Op. cit.*
48. Published at Toronto, 1882.
49. Belief in Immortality, London, 1913, p. 200.
50. Taboo and the Perils of the Soul, London, 1911, p. 254.

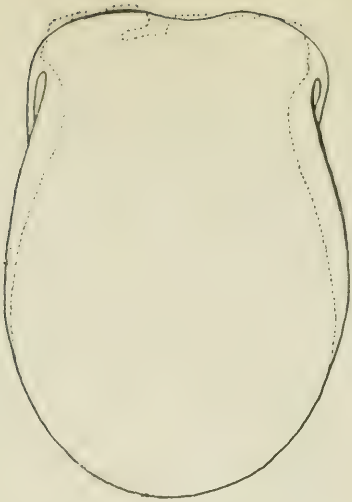

Fig. 1 shows No. 2 skull and the Java calvaria (in dotted outline) both drawn to the same scale and viewed from above. This mode of comparison intensifies the post-orbital construction in the Java specimen. Both outlines were found to coincide posteriorly.

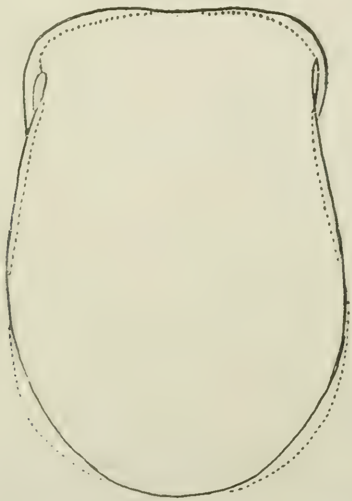

Fig. 2 shows No. 2 skull and the Neanderthal calvaria (in dotted outline) both drawn to the same scale and viewed from above. Note that the post-orbital constriction and the maximum parietal breadth are practically the same in both specimens.

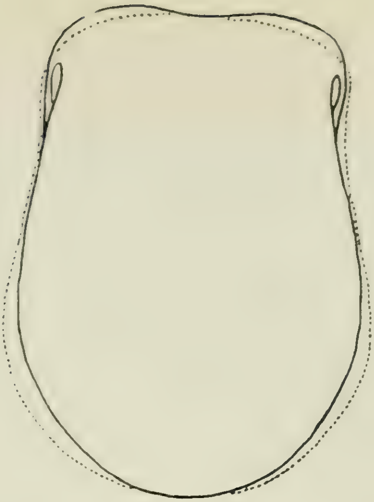

Fig. 3 shows No. 2 skull and the Piltdown skull (in dotted outline) both drawn to the same scale and viewed from above. Note that the post-orbital constriction and the maximum parietal breadth both compare unfavourably with those of the Piltdown specimen.

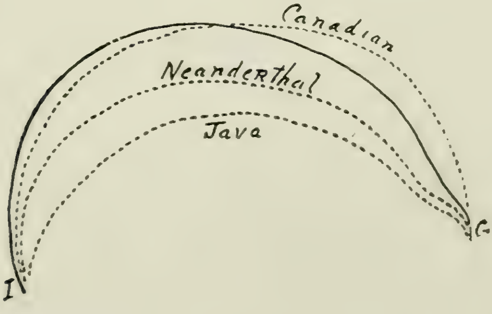

Fig. 4 shows No. 1 skull (in continuous outline), the Java calvaria, the Neanderthal calvaria and a modern Canadian skull all drawn to the same scale for purposes of comparison from the evolutionary standpoint. Note the deficiency of the frontal cranial arc of No. 1 skull and the bulging of the parieto-occipital arc. Note also the "fallen in" appearance of the frontal cranial arc in the lower forms and its obliteration in the Canadian cranium.

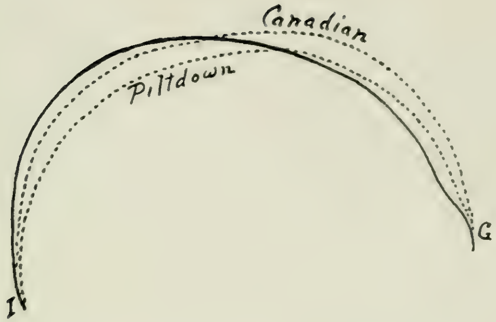

Fig. 5 shows No. 1 skull (in continuous outline), the Piltdown skull and a modern Canadian cranium all drawn to the same scale. Observe the deficiency of the frontal cranial arc of No. 1 skull when compared with the Piltdown and Canadian specimens. G. represents the glabella and I the inion.

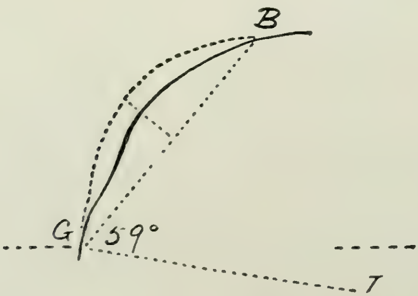

Fig. 6 has been devised to compare the frontal arc of No. 1 skull with that of a modern Canadian cranium possessing the same bregmatic angle (59). The maximum distances of the arc from the glabella-bregma chord were 13.5 and 22 mm. respectively.

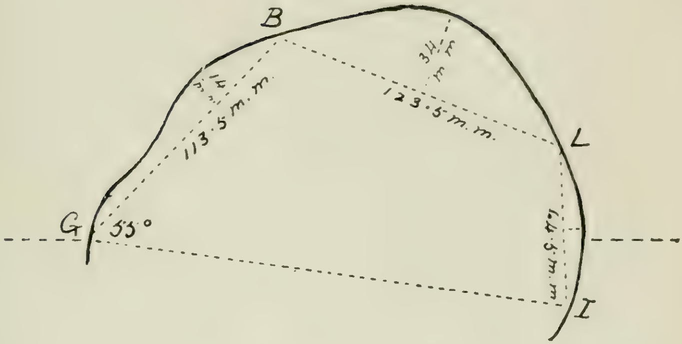

Fig. 7 shows outlines of No. 1 skull (below) and No. 2 skull (above) to illustrate the various cranial curvatures and chords and represent their respective dimensions. The bregmatic angle is also shown. The exceptional height of the paiietal curvature is a striking feature.

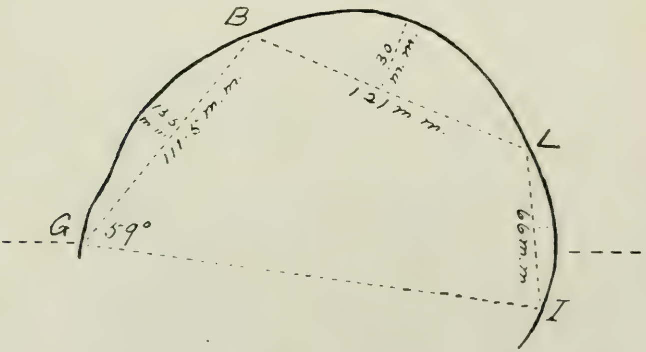

Fig. 7 shows outline of No. 1 skull (below) and No. 2 skull (above) to illustrate the various cranial curvatures and chords and represent their respective dimensions. The bregmatic angle is also shown. The exceptional height of the parietal curvature is a striking feature.

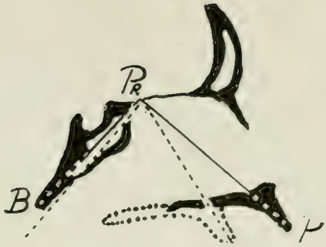

Fig. 8 shows the spheno-maxillary angle (B-PR-P) of No. 1 skull compared with that of a modern Canadian skull (between the dotted lines) which was 75°. The Fig. illustrates the effect which a reduction in the size of this angle has in producing the orthognathous type of cranium.

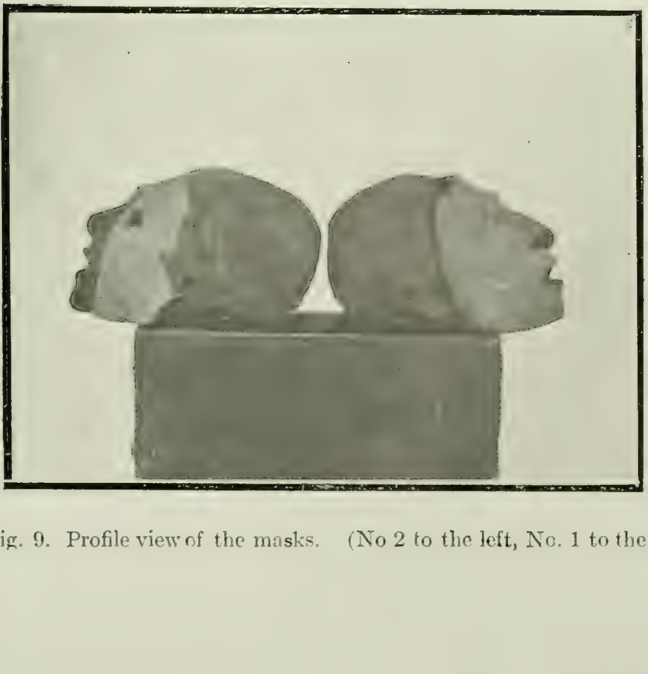

Fig. 9. Profile view of the masks. (No 2 to the left, No. 1 to the right).

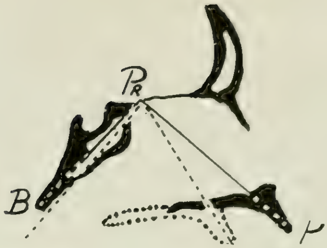

Fig. 8 shows the spheno-maxillary angle (B-PR-P) of No. 1 skull compared with that of a modern Canadian skull (between the dotted lines) which was 75°. The Fig. illustrates the effect which a reduction in the size of this angle has in producing the orthognathous type of cranium.

Fig. 9. Profile view of the masks. (No 2 to the left, No. 1 to the right).

Fig. 10. Full face view of the masks. (No. 2 to the left, No. 1 to the right).

Fig. 11. Three-quarter profile view of the masks. (No. 2 to the left, No. 1 to the right).

I wish to express my indebtedness to Mr. Gordon Smith for taking the photographs of the masks.

APPENDIX I

LIST OF MEMBERS, 1914-15

ORDINARY MEMBERS

Date of Admission

Barnes, Albert Johnstone, B. SC., service inspector, Maritime Telephone & Telegraph Co., Halifax.......May 13, 1912
Bishop, Watson L., Dartmouth, N. S.......Jan. 6, 1890
Bowman, Maynard, B. A., Public Analyst, Halifax.......Mar. 13, 1884
Bronson, Prof. Howard Logan, PH. D., Dalhousie College, Halifax.......Mar. 9, 1911
Brown, Richard H., Halifax.......Feb. 2, 1903
*Campbell. Donald A., M. D., Halifax.......Jan 31, 1890
Campbell, George Murray, M. D., Halifax.......Nov. 10, 1884
Colpitt, Parker R., City Electrician, Halifax.......Feb. 2, 1903
Creighton, Prof. Henry Jeremain Maude, M. A., M. SC., DR. SC., F. C. S., Swarthmore College, Swarthmore, Penn., U. S. A.......Jan. 7, 1908
*Davis, Charles Henry, C. E., New York City, U. S. A.......Dec. 5, 1900
Doane, Francis William Whitney, City Engineer, Halifax.......Nov. 3, 1886
Donkin, Hiram, M. E., Deputy Com. of Mines, Halifax.......Nov. 30, 1892
Fergusson, Donald M., F. C. S., Chemist, Acadia Sugar Ref. Co., Dartmouth..Jan. 5, 1909
*Fraser, Sir C. Frederick, LL. D., Principal, School for the Blind, Halifax.......Mar. 31, 1890
Freeman, Phillip A., Hx., Elect. Tramway Co., Halifax.......Nov. 6, 1906
Graham, Prof. Stanley Newlands, B. SC., N. S. Technical College, Halifax.......Nov. 28, 1913
Harlow, A. C., Montreal.......Jan. 7, 1908
Harris, Prof. David Fraser, M. D., D. SC., F. R. S. E., Dalhousie College, Halifax..Feb. 29, 1912
Hatcher, Prof. Alfred G., Royal Naval College of Canada, Halifax.......Dec. 9, 1914
Hattie, William Harrop, M. D., Dartmouth.......Nov. 12, 1892
Irving, G. W. T., Education Dept., Halifax.......Jan. 4, 1892
Johnstone, J. H. L., Demonstrator of Physics, Dalhousie University, Halifax....Dec. 2, 1912
*Laing, Rev. Robert, Halifax.......Jan. 11, 1885
McCallum, A. L., B. SC., analyst, Halifax.......Jan. 7, 1908
McCarthy, Prof. J. B., B. A., M. SC., King's College, Windsor, N. S.......Dec. 4, 1901
McColl, Roderick, C. E., Halifax.......Jan. 4, 1892
McInnes, Hector, K. C., Halifax.......Nov. 27, 1889
MacIntosh, Prof. Donald Sutherland, B. A., M. SC., Dalhousie College, Halifax.Mar. 9, 1911
*McKay, Alexander, M. A., Supervisor of Schools, Halifax.......Feb. 5, 1872
*MacKay, Alexander Howard, B. A., B. SC., LL. D., F. R. S. C., Superintendent of Education, Halifax.......Oct. 11, 1885
Mackay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax.......Nov. 27, 1889
*MacKay, George M. Johnstone, Schenectady, N. Y., U. S. A.......Dec. 28, 1903
Mackenzie, Prof. Arthur Stanley, PH. D., F. R. S. C., Dalhousie College, Halifax..Nov. 7, 1905
Moore, Prof. Clarence L., M. A., F. R. S. C., Dalhousie College, Halifax.......Jan. 7, 1908
Murphy, Martin, D. SC., I. S. O., Moncton, N. B.......Jan. 15, 1870
Murray, Prof. Daniel Alexander, PH. D., Montreal.......Dec. 18, 1903
Nickerson, Carleton Bell, M. A., Dalhousie College, Halifax.......Mar. 9, 1911

*Life Members.

Date of Admission

Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax .... Nov. 2, 1888
*Poole, Henry Skeffington, A. M., ASSOC., R. S. M., F. G. S., F. R. S. C., CAN. SOC. C. E., HON. MEM. INST. M. E., Guildford, Surrey, England .... Nov. 11, 1872
Richardson, Prof. Lorne N., Royal Naval College of Cnnada, Halifax .... Dec. 9, 1914
*Robb, D. W., Amherst, N. S .... Mar. 4, 1890
Sexton, Prof. Frederic H., S. B., Director of Technical Education, Halifax .... Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agricultural College, Truro, N. S.; Assoc. Memb. Jan. 6, 1890 .... Dec. 1900
*Stewart, John, M. B., C. M., Halifax .... Jan. 12, 1885
Winfield, James H., Manager Mar. Tel. & Tel. Co., Halifax .... Dec. 18, 1903
*Yorston, W. G., C. E., Assistant Road Commissioner, Halifax .... Nov. 12, 1892

ASSOCIATE MEMBERS

Allen, E. Chesley, Yarmouth, N. S .... Nov. 28, 1913
*Caie, Robert, Yarmouth, N. S .... Jan. 31, 1890
Connolly, Prof. C. J., PH. D., Univ. of St. Francis Xavier, Antigonish, N. S .... Nov. 5, 1911
Haley, Prof. Frank R., Acadia College, Wolfville, N. S .... Nov. 5, 1901
Harlow, L. C., B. SC., Prov. Agricultural College, Truro, N. S .... Mar. 23, 1905
Haycock, Prof. Ernest, Acadia College, Wolfville, N. S .... May. 17, 1899
James, C. C., LL. D., C. M. G., Toronto, Ontario .... Dec. 3, 1896
Jennison, W. F., Truro, N. S .... May 5, 1903
*Johns, Thomas W., Yarmouth, N. S .... Nov. 27, 1889
*MacKay, Hector H., M. D., New Glasgow, N. S .... Feb. 4, 1902
Payzant, E. N., M. D., Wolfville, N. S .... Apr. 8, 1902
Perry, Prof. Horace Greeley, M. A., Acadia University, Wolfville, N. S .... May 12, 1913
Pineo, Avard V., LL. B., Kentville, N. S .... Nov. 5, 1901
*Reid, A. P., M. D., L. R. C. S., Middleton, Annapolis, N. S .... Jan. 31, 1890

*Life Members.

CORRESPONDING MEMBERS

	Date of Admission
Ami, Henry M., D. SC., F. G. S., F. R. S. C., Geological Survey, Ottawa, Ontario....Jan.	2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. S. C., Fredericton, N. B.................Jan.	6, 1890
Ball. Rev. E. H., Tangier, N. S. ....Nov.	29, 1871
Barbour, Capt. J. H., R. A. M. C., F. L. S., care of Holt & Co., 3, Whitehall Place, London, S. W., England.....................................Dec.	28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Ontario Agricultural College, Guelph, Ontario..Dec.	29, 1868
Cox, Prof. Philip, B. SC., PH. D., Fredericton, N. B. ....Dec.	3, 1902
Dobie, W. Henry, M. D., Chester, England...................................Dec.	3, 1897
Fairbault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa; Assoc. Memb. March 6, 1888.......................................Dec.	3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U. S. A..Jan.	6, 1890
Hardy, Maj-General Campbell, R. A., Dover, England, (Sole surviving Foundation Member; originally elected Dec. 26th, 1862. and admitted Jan. 26, 1862)...Oct.	30, 1903
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B..................Jan.	6, 1890
Mowbray, Louis L., Hamilton, Bermuda.....................................May	3, 1907
Peter, Rev. Brother Junian ....Dec.	12, 1898
Prest, Walter Henry, M. E., Bedford, N. S.; Assoc. Memb. Nov. 29, 1894........Nov.	2, 1900
Prichard, Arthur H. Cooper, Librarian Numismatic Museum, New York, U.S.A.Dec.	4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa...Jan.	5, 1897

APPENDIX II

LIST OF MEMBERS, 1915-16

ORDINARY MEMBERS

Date of Admission

Barnes, Albert Johnstone, b. sc., service inspector Maritime Telephone & Telegraph Co., Halifax....May 13, 1912
Bishop, Watson L., Dartmouth, N. S....Jan. 6, 1890
Bowman, Maynard, b. a., Public Analyst, Halifax....Mar. 13, 1884
Bronson, Prof. Howard Logan, ph. d., f. r. s. c., Dalhousie University, Halifax..Mar. 9, 1911
Brown, Richard H., Halifax....Feb. 2, 1903
*Campbell, Donald A., m. d., Halifax....Jan. 31, 1890
Campbell, George Murray, m. d., Halifax....Nov. 10, 1884
Cameron, Prof. John, m. d., d. sc., f. r. s. e., Dalhousie University, Halifax....Nov. 2, 1915
Colpitt, Parker R., City Electrician, Halifax....Feb. 2, 1903
Creighton, Prof. Henry Jermain Maude, m. a., m. sc., dr. sc. (Zürich), f. c. s., Swarthmore College, Swarthmore, Penn., U. S. A....Jan. 7, 1908
*Davis, Charles Henry, c. e., New York City, U. S. A....Dec. 5, 1900
Doane, Francis William Whitney, City Engineer, Halifax....Nov. 3, 1886
Donkin, Hiram, m. e., Deputy Com. of Mines, Halifax....Nov. 30, 1892
*Fergusson, Donald M., chemist, Acadia Sugar Ref. Co., Dartmouth, N. S....Jan. 5, 1909
*Fraser, Sir C. Frederick, ll. d., Principal School for the Blind, Halifax....Mar. 31, 1890
Freeman, Philip A., Hx. Elect. Tramway Co., Halifax....Nov. 6, 1906
Graham, Prof. Stanley Newlands, b. sc., N. S. Technical College, Halifax....Nov. 28, 1913
Harris, Prof. David Fraser, m. b., c. m., m. d., b. sc. (Lond.), d. sc., f. r. s. e., f. r. s. c., l. m. c. c., Dalhousie University, Halifax....Feb. 29, 1912
Hatcher, Prof. Alfred G., Royal Naval College of Canada, Halifax....Dec. 9, 1914
Hattie, William Harrop, m. d., Provincial Health Officer, Dartmouth....Nov. 12, 1892
Henderson, Lieut. George Hugh, c. e., b. sc., m. a., Instructor in Physics, Dalhousie University, Halifax....Nov. 2, 1915
Irving, G. W. T., Education Dept., Halifax....Jan. 4, 1892
Johnstone, Lieut. John Hamilton Lane, c. e., b. a., m. sc., ph. d., Overseas Force. Dec. 2, 1912
*Laing, Rev. Robert, Halifax....Jan. 11, 1885
McCarthy, Prof. Joseph B., b. a., m. sc., King's College, Windsor, N. S....Dec. 4, 1901
McDougall, John G., m. d., c. m., Lecturer in Clinical Surgery, Dalhousie University, Halifax....Nov. 2, 1915
McInnes, Hector, k. c., m. p. p., Halifax....Nov. 27, 1889
MacIntosh, Prof. Donald Sutherland, b. a., m. sc., Dalhousie University, Halifax....Mar. 9, 1911
*McKay, Alexander, m. a., Supervisor of Schools, Halifax....Feb. 5, 1872
*MacKay, Alexander Howard, b. a., b. sc., ll. d., f. r. s. c., Hon. Colonel, Superintendent of Education, Halifax....Oct. 11, 1885
Mackay, Prof. Ebenezer, ph. d., Dalhousie College, Halifax....No.v 27, 1889
*MacKay, George M. Johnstone, m. a., m. s., Schenectady, N. Y., U. S. A....Dec. 28, 1903
MacKenzie, President Arthur Stanley, ph. d., f. r. s. c., Dalhousie University, Halifax....Nov. 7, 1905
Matheson, Donald J., Science Master, Halifax County Academy, Halifax....Nov. 2, 1915
Moore, Prof. Clarence Leander, m. a., f. r. s. c., Dalhousie University, Halifax. Jan. 7, 1908

*Life Members.

Date of Admission

Murray, Prof. Daniel Alexander, PH. D., Montreal........................Dec. 18, 1903
Nicholls, Prof. Albert G., M. D., D. SC., F. R. S. C., Dalhousie University, Halifax. Nov. 2, 1915
Nickerson, Carleton Bell, M. A., Demonstrator in Chemistry, Dalhousie University, Halifax........................Mar. 9, 1911
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax........................Nov. 2, 1888
*Poole, Henry Skeffington, A. M., ASSOC. R. S. M., F. G. S., F. R. S. C., CAN. SOC. C. E., HON. MEM. INST. M. E., Guildford, Surrey, England..............Nov. 11, 1872
Richardson, Prof. Lorne N., Royal Naval College of Canada, Halifax.........Dec. 9, 1914
*Robb, D. W., Amherst, N. S........................Mar. 4, 1890
Sexton, Prof. Frederic H., B. SC., Director of Technical Education, Halifax....Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agricultural College, Truro, N. S.; Assoc. Memb. Jan. 6, 1890........................Dec. 1900
*Stewart, Lieut. Col. John, M. B., C. M., 7th Station Hospital Unit, France. ....Jan. 12, 1885
Vickery, Hubert Bradford, Science Master, Bloomfield High School, Halifax...Nov. 2, 1915
Winfield, James H., Manager Mar. Tel. & Tel. Co., Halifax.................Dec. 18, 1903
*Yorston, William G., C. E., Assistant Road Commissioner, Halifax...........Nov., 12, 1892

ASSOCIATE MEMBERS

Allen, E. Chesley, Truro, N. S........................Nov. 28, 1913
Barteaux, James E., M. A., Inspector of Manual Training and Technical Schools, Truro, N. S........................Nov. 2, 1915
*Caie, Robert, Yarmouth, N. S........................Jan. 31, 1890
Connolly, Prof. J. C., PH. D., St. Francis Xavier, Antigonish, N. S............Nov. 5, 1911
Brittain, Prof. William H., B. S. A., Provincial Entomologist, Truro, N. S......Nov. 2, 1915
Cumming, Principal Melville, B. A., B. S. A., N. S. College of Agriculture, Truro...Nov. 2, 1915
DeWolfe, Loran A., M. SC., Director of Rural Science Schools, Truro, N. S....No.v 2, 1915
Haley, Prof. Frank R., Acadia College, Wolfville, N. S........................Nov. 5, 1901
Harlow, L. C., B. SC., PH. D., College of Agriculture, Truro, N. S............Mar. 23, 1905
Haycock, Prof. Ernest, Acadia College, Wolfville, N. S........................May 17, 1899
Jennison, W. F., Truro, N. S........................May 5, 1903
*Johns, Thomas W., Yarmouth, N. S........................Nov. 27, 1889
*MacKay, Hector H., M. D., New Glasgow, N. S........................Feb. 4, 1902
Payzant, E. N., M. D., Wolfville, N. S........................Apr. 8, 1902
Perry, Prof. Horace Greeley, M. A., Acadia University, Wolfville, N. S........May 12, 1913
Pineo, Avard V., LL. B., Kentville, N. S........................Nov. 5, 1901
*Reid, A. P., M. D., L. R. C. S., Middleton, Annapolis, N. S..................Jan. 31, 1890
Scott, Prof. J. M., M. A., M. SC., Provincial Normal College, Truro, N. S.......Nov. 2, 1915
Shaw, Prof. Percy J., B. A., N. S. College of Agriculture, Truro, N. S.........Nov. 2, 1915

*Life Members.

CORRESPONDING MEMBERS

	Date of Admission
Ami, Henry M., D. SC., F. G. S., F. R. S. C., Geological Survey, Ottawa, Ontario	Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. S. C., Fredericton, N. B.	Jan. 6, 1890
Ball, Rev. E. H., Tangier, N. S.	Nov. 29, 1871
Barbour, Major J. H., R. A. M. C., F. L. S., No. 1 Base Depot Medical Stores, Boulogne, France	Dec. 28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Ontario Agricultural College, Guelph, Ontario	Dec. 29, 1868
Cox, Prof. Phillip, B. SC., PH. D., Fredericton, N. B.	Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England	Dec. 3, 1897
Faribault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa; Assoc. Memb. March 6, 1888	Dec. 3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U.S.A.	Jan. 6, 1890
Hardy, Maj.-General Campbell, R. A., Dover, England. (Sole surviving Foundation Member; originally elected Dec. 26, 1862, and admitted Jan. 26, 1862)	Oct. 30, 1903
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B.	Jan. 6, 1890
Mowbray, Louis L., curator, Bermuda Natural History Society, Hamilton, Bermuda	May 3, 1907
Peter, Rev. Brother Junian	Dec. 12, 1898
Prest, Walter Henry, M. E., Bedford, N. S.; Assoc. Memb., Nov. 29, 1894	Nov. 2, 1900
Prichard, Arthur H. Cooper, British School of Archæology, Rome, Italy	Dec. 4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa	Jan. 5, 1897

LIST OF PRESIDENTS

OF THE NOVA SCOTIAN INSTITUTE OF NATURAL SCIENCE, AFTERWARDS THE NOVA SCOTIAN INSTITUTE OF SCIENCE, SINCE ITS FOUNDATION ON 31ST DECEMBER, 1862.

	Term of Office
Hon. Philip Carteret Hill, D. C. L.	31 Dec. 1862 to 26 Oct. 1863
John Matthew Jones, F. L. S., F. R. S. C.	26 Oct. 1863 " 8 Oct. 1873
John Bernard Gilpin, M. A., M. D., M. R. S. C.	8 Oct. 1873 " 9 Oct. 1878
William Gossip	9 Oct. 1878 " 13 Oct. 1880
John Somers, M. D.	13 Oct. 1880 " 26 Oct. 1883
Robert Morrow	26 Oct. 1883 " 21 Oct. 1885
John Somers, M. D.	21 Oct. 1885 " 10 Oct. 1888
Prof. James Gordon MacGregor, M.A., D.SC., F.R.S., F.R.S.C.	10 Oct. 1888 " 9 Nov. 1891
Martin Murphy, C.E., D.SC., O.S.I.	9 Nov. 1891 " 8 Nov. 1893
Prof. George Lawson, PH.D., LL.D., F.I.C., F.R.S.C.	8 Nov. 1893 " 10 Nov. 1895
Edwin Gilpin, Jr., M.A., LL.D., D.SC., F.G.S., F.R.S.C., I.S.O.	18 Nov. 1895 " 8 Nov. 1897
Alexander McKay, M.A.	8 Nov. 1897 " 20 Nov. 1899
Alexander Howard MacKay, B.A., B.SC., LL.D., F.R.S.C.	20 Nov. 1899 " 24 Nov. 1902
Henry Skeffington Poole, M.A., D.SC., A.R.S.M., F.G.S., F.R.S.C.	24 Nov. 1902 " 18 Oct. 1905
Francis William Whitney Doane, C. E.	18 Oct. 1905 " 11 Nov. 1907
Prof. Ebenezer Mackay, PH.D.	11 Nov. 1907 " 12 Dec. 1910
Watson Lenley Bishop	12 Dec. 1910 " 11 Nov. 1912
Donald MacEachern Fergusson, F.C.S.	11 Nov. 1912 " 13 Oct. 1915
Prof. David Fraser Harris, M.B., C.M., M.D., B.SC. (Lond.), D.SC., F.R.S.E., F.R.S.C., L.M.C.C.	13 Oct. 1915 " ——

NOTE—Since 1879 the presidents of the Institute have been *ex-officio* Fellows of the Royal Microscopical Society.

The first general meeting of the Nova Scotian Institute of Natural Science was held at Halifax, on 31st December, 1862. On 24th March, 1890, the name of the society was changed to the Nova Scotian Institute of Science, and it was incorporated by an act of the legislature in the same year.

The foundation of the Halifax Mechanics' Institute on 27th December, 1831, and of the Nova Scotian Literary and Scientific Society about 1859 (the latter published its Transaction from 4th January to 3rd December, 1859) had led up to the establishment of the N. S. Institu of Natural Science in December, 1862.

APPENDIX II

LIST OF MEMBERS, 1916-17

ORDINARY MEMBERS

Date of Admission

Barnes, Albert Johnstone, B. SC., service inspector Maritime Telephone & Telegraph Co., Halifax.......... May 13, 1912
Bishop, Watson L., Dartmouth, N. S.......... Jan. 6, 1890
Blackader, Edward, M. D., Halifax.......... Sept. 27, 1917
Bowman, Maynard, B. A., Public Analyst, Halifax.......... Mar. 13, 1884
Bronson, Prof. Howard Logan, PH. D., F. R. S. C., Dalhousie University, Halifax.. Mar. 9, 1911
*Campbell, Donald A., M. D., Halifax.......... Jan. 31, 1890
Campbell, George Murray, M. D., Halifax.......... Nov. 10, 1884
Cameron, Prof. John, M. D., D. SC., F. R. S. E., Dalhousie University, Halifax.... Nov. 2, 1915
Colpitt, Parker R., City Electrician, Halifax.......... Feb. 2, 1903
Creighton, Prof. Henry Jermain Maude, M. A., M. SC., DR. SC. (Zürich), F. C. S., Swarthmore College, Swarthmore, Penn., U. S. A.......... Jan. 7, 1908
*Davis, Charles Henry, C. E., New York City, U. S. A.......... Dec. 5, 1900
Doane, Francis William Whitney, City Engineer, Halifax (O. A. S.).......... Nov. 3, 1886
Donkin, Hiram, M. E., Deputy Com. of Mines, Halifax.......... Nov. 30, 1892
*Fergusson, Donald M., chemist, Acadia Sugar Ref. Co., Dartmouth, N. S.... Jan. 5, 1909
Forward, Charles C., Inland Revenue Laboratory, Halifax.......... Jan. 5, 1917
*Fraser, Sir C. Frederick, LL. D., Principal School for the Blind, Halifax....... Mar. 31, 1890
Freeman, Philip A., Hx. Elect. Tramway Co., Halifax.......... Nov. 6, 1906
Graham, Stanley Newlands, B. SC., Cobalt, Ont.......... Nov. 28, 1913
Harris, Prof. David Fraser, M. B., C. M., M. D., B. SC. (Lond.), D. SC., F. R. S. E., F. R. S. C., L. M. C. C., Dalhousie University, Halifax.......... Feb. 29, 1912
Hatcher, Prof. Alfred G., Royal Naval College of Canada, Kingston, Ont. .... Dec. 9, 1914
Hattie, William Harrop, M. D., Provincial Health Officer, Dartmouth.......... Nov. 12, 1892
Henderson, Lieut. George Hugh, C. E., B. SC., M. A., Instructor in Physics, Dalhousie University, Halifax (O. A. S.).......... Nov. 2, 1915
Irving, G. W. T., Education Dept., Halifax.......... Jan. 4, 1892
Johnstone, Lieut. John Hamilton Lane, C. E., B. A., M. SC., PH. D., Overseas Force. Dec. 2, 1912
*Laing, Rev. Robert, Halifax.......... Jan. 11, 1885
McCarthy, Prof. Joseph B., B. A., M. SC., King's College, Windsor, N. S....... Dec. 4, 1901
McDougall, John G., M. D., C. M., Lecturer in Clinical Surgery, Dalhousie University, Halifax.......... Nov. 2, 1915
McInnes, Hector, K. C., M. P. P., Halifax.......... Nov. 27, 1889
McIntosh, Prof. Donald Sutherland, B. A., M. SC., Dalhousie University, Halifax.......... Mar. 9, 1911
*MacKay, Alexander Howard, B. A., B. SC., LL. D., F. R. S. C., Hon. Colonel, Superintendent of Education, Halifax.......... Oct. 11, 1885
Mackay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax.......... No.v 27, 1889
*MacKay, George M. Johnstone, M. A., M. S., Schenectady, N. Y., U. S. A..... Dec. 28, 1903
MacKenzie, President Arthur Stanley, PH. D., F. R. S. C., Dalhousie University, Halifax.......... Nov. 7, 1905
Matheson, Donald J., Science Master, Halifax County Academy, Halifax..... Nov. 2, 1915
Moore, Prof. Clarence Leander, M. A., F. R. S. C., Dalhousie University, Halifax. Jan. 7, 1908
Murray, Prof. Daniel Alexander, PH. D., Montreal.......... Dec. 18, 1903
Nicholls, Prof. Albert G., M. D., D. SC., F. R. S. C., Dalhousie University, Halifax. Nov. 2, 1915
Nickerson, Carleton Bell, M. A., Demonstrator in Chemistry, Dalhousie University, Halifax.......... Mar. 9, 1911
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax.......... Nov. 2, 1888

*Life Members.

Date of Admission

Richardson, Prof. Lorne N., Royal Naval College of Canada, Kingston, Ont...Dec. 9, 1914
*Robb, D. W., Amherst, N. S....Mar. 4, 1890
Sexton, Prof. Frederic H., B. SC., Director of Technical Education, Halifax....Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agricultural College, Truro, N. S.; Assoc. Memb. Jan. 6, 1890....Dec. 1900
*Stewart, Lieut. Col. John, M. B., C. M., 7th Station Hospital Unit, France....Jan. 12, 1885
Vickery, Hubert Bradford, M. Sc., Halifax....Nov. 2, 1915
Winfield, James H., Manager Mar. Tel. & Tel. Co., Halifax....Dec. 18, 1903
Woodbury, William W., B. SC., D. D. S., Halifax....Nov. 30, 1916
*Yorston, William G., C. E., Assistant Road Commissioner, Halifax....Nov., 12, 1892

ASSOCIATE MEMBERS

Allen, E. Chesley, Truro, N. S....Nov. 28, 1913
Barteaux, James E., M. A., Inspector of Manual Training and Technical Schools, Truro, N. S....Nov. 2, 1915
Brittain, Prof. William H., B. S. A., Provincial Entomologist, Truro, N. S....Nov. 2, 1915
*Caie, Robert, Yarmouth, N. S....Jan. 31, 1890
Connolly, Prof. J. C., PH. D., St. Francis Xavier, Antigonish, N. S....Nov. 5, 1911
Cumming, Principal Melville, B. A., B. S. A., N. S. College of Agriculture, Truro...Nov. 2, 1915
DeWolfe, Loran A., M. SC., Director of Rural Science Schools, Truro, N. S....Nov. 2, 1915
Haley, Prof. Frank R., Acadia College, Wolfville, N. S....Nov. 5, 1901
Harlow, L. C., B. SC., PH. D., College of Agriculture, Truro, N. S....Mar. 23, 1905
Jennison, W. F., Truro, N. S....May 5, 1903
*Johns, Thomas W., Yarmouth, N. S....Nov. 27, 1889
*MacKay, Hector H., M. D., New Glasgow, N. S....Feb. 4, 1902
Payzant, E. N., M. D., Wolfville, N. S....Apr. 8, 1902
Perry, Prof. Horace Greeley, M. A., Acadia University, Wolfville, N. S....May 12, 1913
Pineo, Avard V., LL. B., Kentville, N. S....Nov. 5, 1901
*Reid, A. P., M. D., L. R. C. S., Middleton, Annapolis, N. S....Jan. 31, 1890
Scott, Prof. J. M., M. A., M. SC., Provincial Normal College, Truro, N. S....Nov. 2, 1915
Shaw, Prof. Percy J., B. A., N. S. College of Agriculture, Truro, N. S....Nov. 2, 1915

CORRESPONDING MEMBERS

Ami, Henry M., D. SC., F. G. S., F. R. S. C., Geological Survey, Ottawa, Ontario..Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. S. C., Fredericton, N. B....Jan. 6, 1890
Ball, Rev. E. H., Tangier, N. S....Nov. 29, 1871
Barbour, Major J. H., R. A. M. C., F. L. S., No. 1 Base Depot Medical Stores, Boulogne, France....Dec. 28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Ontario Agricultural College, Guelph, Ontario....Dec. 29, 1868
Cox, Prof. Phillip, B. SC., PH. D., Fredericton, N. B....Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England....Dec. 3, 1897
Faribault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa; Assoc. Memb. March 6, 1888....Dec. 3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U.S.A...Jan. 6, 1890
Gates, Reginald Ruggles, PH. D., F. L. S., London, Eng. ....Nov. 30, 1916
Hardy, Maj.-General Campbell, R. A., Dover, England. (Sole surviving Foundation Member; originally elected Dec. 26, 1862, and admitted Jan. 26, 1862)....Oct. 30, 1903
Matheson, Prof. Robert, PH D., Cornwall University, Ithaca ....Nov. 30, 1916
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B....Jan. 6, 1890
Mowbray, Louis L., curator, Bermuda Natural History Society, Hamilton, Bermuda....May 3, 1907
Peter, Rev. Brother Junian....Dec. 12, 1898
Prest, Walter Henry, M. E., Bedford, N. S.; Assoc. Memb., Nov. 29, 1894 (O;A.S.) Nov. 2, 1900
Prichard, Arthur H. Cooper, British School of Archæology, Rome, Italy....Dec. 4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa..Jan. 5, 1897

*Life Members.

APPENDIX IV.

LIST OF MEMBERS, 1917-1918.

ORDINARY MEMBERS.

	Date of Admission
Barnes, Albert Johnstone, B. SC., Maritime Teleph. & Telegr. Co., Halifax..May	13, 1912
Bishop, Waton L., Dartmouth, N. S..Jan.	6, 1890
Blackadder, Edward, M. D., Halifax....................................Sept.	27, 1917
*Bronson, Prof. Howard Logan, PH. D., F. R. S. C., Dalhousie University, Halifax Mar.	9, 1911
*Campbell, Donald A., M. D., Halifax, (Died Jan. 7, 1919)..................Jan.	31, 1890
Campbell, George Murray, M. D., Halifax................................Nov.	10, 1884
Cameron, Prof. John, M. D., D. SC., F. R. S. E., Dalhousie University, Halifax..Nov.	2, 1915
Colpitt, Parker R., City Electrician, Halifax.............................Feb.	2, 1903
Creighton, Prof. Henry Jermain Maude, M. A., M. SC., DR. SC., (Zurich), F. C. S., Swarthmore College, Swarthmore, Penn., U. S. A.....................Jan.	7, 1908
*Davis, Charles Henry, C. E., New York City, U. S. A.....................Dec.	5, 1900
*Doane, Francis William Whitney, City Engineer, Halifax (O. A. S.).........Nov.	3, 1886
Donkin, Hiram, M. E., Deputy Com. of Mines, Halifax.....................Nov.	30, 1892
*Fergusson, Donald M., chemist, Acadia Sugar Ref. Co., Dartmouth, N. S...Jan.	5, 1909
Forward, Charles C., Inland Revenue Laboratory, Halifax..................Jan.	5, 1917
*Fraser, Sir C. Frederick, LL. D., Principal School for the Blind, Halifax......Mar.	31, 1890
Freeman, Philip A., Hx. Elec. Tramway Co., Halifax.......................Nov.	6, 1906
Harris, Prof. David Fraser, M. B., C. M., M. D., B. SC. (Lond.), D. SC., F. R. S. .., F. R. S. C., L. M. C. C., Dalhousie University, Halifax.....................Feb.	29, 1912
Hatcher, Prof. Alfred G., Royal Naval College of Canada, Esquimault, B. C..Dec.	9, 1914
Hattie, William Harrop, M. D., Provincial Health Officer, Dartmouth.........Nov.	12, 1892
Irving, G. W. T., Education Dept., Halifax...............................Jan.	4, 1892
Johnstone, Capt. John Hamilton Lane, C.E., B.A., M.SC., PH.D., Overseas Force...Dec.	2, 1912
*Laing, Rev. Robert, Halifax (Died Apr. 19, 1919).........................Jan.	11, 1885
McCarthy, Prof. Joseph B., B. A., M. SC., King's College, Windsor, N. S......Dec.	4, 1901
McDougall, John G., M. D., C. M., Lecturer in Clinical Surgery, Dalhousie University, Halifax...Nov.	2, 1915
McInnes, Hector, K. C., M. P. P., Halifax..................................Nov.	27, 1889
McIntosh, Prof. Donald Sutherland, B, A., M. SC., Dalhousie University, Halifax...Mar.	9, 1911
*MacKay, Alexander Howard, B. A., B. SC., LL. D., F. R. S. C., Hon. Colonel, Superintendent of Education, Halifax..............................Oct.	11, 1885
Mackay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax.................Nov.	27, 1889
*MacKay, George M. Johnstone, M. A., M. S., Schenectady, N. Y., U. S. A....Dec.	28, 1903
*MacKenzie, President Arthur Stanley, PH. D., F. R. S. C., Dalhousie University, Halifax...Nov.	7, 1905
Matheson, Donald J., B. SC., Science Master, Halifax County Academy, Halifax Nov.	2, 1915
Moore, Prof. Clarence Leander, M.A., F.R.S.C., Dalhousie University, Halifax....Jan.	7, 1908
Murray, Prof. Daniel Alexander, PH. D., Montreal.........................Dec.	18, 1903
*Nicholls, Prof. Albert G., M. D., D. SC., F. R. S. C., Dalhousie University, Halifax.Nov.	2, 1915
Nickerson, Carleton Bell, M. A., Demonstrator in Chemistry, Dalhousie University, Halifax...Mar.	9, 1911
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax...Nov.	2, 1888

*Life Members.

	Date of Admission
Richardson, Prof. Lorne N., Royal Naval College of Canada, Esquimalt, B. C.	Dec. 9, 1914
*Robb, D. W., Amherst, N. S.	Mar. 4, 1890
Sexton, Prof. Frederic H., B. SC., Director of Technical Education, Halifax	Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agr. Col., Truro, N. S.; Assoc. Memb Jan. 6, 1890.	Dec. 1900
*Stewart, Lieut. Col. John, M. B., C. M., 7th Station Hospital Unit, France	Jan. 12, 1885
Vickery, Hubert Bradford, M. Sc., Halifax	Nov. 2, 1915
Winfield, James H., manager Mar. Tel & Tel. Co., Halifax	Dec. 2, 1903
Woodbury, William W., B. SC., D. D. S., Halifax	Nov. 30, 1916
*Yorston, William G., C. E., Assistant Road Commissioner, Halifax	Nov. 12, 1892

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Brittain, Prof. William H., B. S. A., Provincial Entomologist, Truro, N. S.	Nov. 2, 1915
*Caie, Robert, Yarmouth, N. S	Jan. 31, 1890
Connolly, Prof. J. C., PH. D., St. Francis Xavier College, Antigonish, N. S.	Nov. 5, 1911
Cumming, Principal Melville, B. A., B. S. A., N. S. College of Agricultural, Truro	Nov. 2, 1915
DeWolfe, Loran A., M. SC., Director of Rural Science Schools, Truro, N. S.	Nov. 2, 1915
Haley, Prof. Frank R., Acadia College, Wolfville, N. S	Nov. 5, 1901
Harlow, L. C., B. SC., PH. D., College of Agriculture, Truro, N. S	Mar. 23, 1905
*Henderson, Lieut George Hugh C, E., B. Sc., M. A. O. A. S.	Nov. 2, 1915
*Johns, Thomas W., Yarmouth, N. S	Nov. 27, 1889
*MacKay, Hector H., M. D., New Glasgow, N. S	Feb. 4, 1902
Payzant, E. N., M. D., Wolfville, N. S	Apr. 8, 1902
Perry, Prof. Horace Greeley, M. A., Acadia University, Wolfville, N. S.	May 12, 1913
*Reid, A. P., M. D., L. R. S. C., Middleton, Annapolis, N. S	Jan. 31, 1890
Scott, Prof. J. M., M. A., M. SC., Provincial Normal College, Truro, N. S.	Nov. 2, 1915
Shaw, Prof. Percy J., B. A., N. S. College of Agriculture, Truro, N. S	Nov. 2, 1915

CORRESPONDING MEMBERS.

Ami, Henry M., D. SC., F. G. S., F. R. S. C., Geological Survey, Ottawa, Ontario	Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. S. C., Fredericton, N. B	Jan. 6, 1890
Ball, Rev. E. H., Mink Cove, N. S.	Nov. 29, 1871
Barbour, Major J. H., R. A. M. C., F. L. S., No. 1 Base Depot Medical Stores, Boulogne, France	Dec. 28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., O. A. C., Guelph, Ontario.	Dec. 29, 1868
Cox, Prof. Philip, B. SC., PH. D., Fredericton, N. B	Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England	Dec. 3, 1897
Faribault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa: Assoc. Memb. March 6, 1888	Dec. 3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U.S.A.	Jan. 6, 1890
Gates, Reginald Ruggles, PH. D., F. L. S., London, Eng	Nov. 30, 1916
Hardy, May.-General Campbell, R. A., Dover England. (Sole surviving Foundation Member; originally elected Dec. 26, 1862, and admitted Jan. 26, 1862; (Died 11 April, 1919)	Oct. 30, 1903
Matheson, Prof. Robert, PH. D., Cornwall University, Ithaca	Nov. 30, 1916
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B	Jan. 6, 1890
Mowbray, Louis L., curator, Bermuda Natural History Society, Hamilton, Bermuda	May 3, 1907
Peter, Rev. Brother Junian	Dec. 12, 1898
Prest, Walter Henry, Halifax, N. S.; Assoc. Memb. Nov. 29, 1894 (O.A.S)	Nov. 2, 1900
Prichard, Arthur H. Cooper, British School of Archæology, Rome, Italy	Dec. 4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa	Jan. 5, 1897

*Life Members.

INDEX

VOLUME, XIV.

(*Roman numerals refer to the Proceedings. Arabic numerals to the pages of the Transactions.*)

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications:—

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society."